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Contents

Page

ARTICLES—

Thornthwaite's Climatic Formula, by G. W. Leeper .. 2
Field Survey of a Primary Industry, by P. S. Lang .. 6

TECHNICAL PAPERS—

A Mapping System for the Compilation of a Soil Map of Australia, by C. G. Stevens 10
Red and Brown Hard Pan Soils of Western Australia, by L. H. J. Teakle 15
Birds as a Biotic Factor in the Environment of Pastures with Special Reference to Galahs, by G. H. Allen 18
Infiltration Studies on a Red-brown Earth in the Riverina, by A. L. Tisdall 26

TECHNICAL NOTES—

The Occurrence of Scorzonera calcitrapifolia Vahl. at Deniliquin, N.S.W., by O. B. Williams 30
The Susceptibility of Peas to Four Diseases Occurring Naturally in the Australian Capital Territory, by D. C. Wark 32
Some Instances of Great Variability in Incidence of Brown Rot of Stone Fruits in Canberra in 1949-50, by H. R. Angell 33

INSTITUTE AFFAIRS—

Annual Report of Council 35
Financial Statements 38
Australian Journal of Agricultural Research 39

GENERAL—

Travel Leave for Agricultural Scientists 40
C.A.B. News Notes 41

DIGESTS 42

STATE SUB-EDITORS:

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ARTICLES

THORNTHWAITE'S CLIMATIC FORMULA

By G. W. LEEPER

Thornthwaite's name is prominent among the inventors of formulae for effectiveness of rainfall. His latest contribution to the subject [3] is likely to have widespread use, and this article is concerned with it.

The problem before us can be put simply: A twenty-inch rainfall in Tasmania has a different effect from a twenty-inch rainfall in Queensland. Since evaporation and transpiration in Tasmania are slow, the soil stays moist for a longer period between falls of rain, so that periods of hardship for the plant are less deadly and less frequent; also there is more chance that rain may fall on already moist soil and cause run-off either on the surface or by drainage through the subsoil. Can we devise a formula which will allow for this difference in the rate of loss of water?

The problem can be put simply, but it has no simple answer.

The most attractive way of approach is by monthly figures. We have here the various formulae developed at the Waite Institute combining rainfall (P) and the evaporation from a standard three-foot tank (E); firstly that rain greater than E/3 in one month is effective [4], and later that rain greater than $0.4 \times E^{0.75}$ (in inches) is effective, (Prescott, private communication). By such formulae we can write down the number of months in which the soil remains moist. More stringent tests must be devised to include transpiration. Since the direct value for E is seldom available, it was first estimated from the saturation deficit by the approximate rule $E = 21s.d.$

An early formula of Thornthwaite had something in common with these. The first stage was to work out for each month the value $\left(P/(T-10) \right)^{10/9}$ where T is the fahrenheit temperature. One could then find the number of months in which the value corresponded to effective rain, just as the Waite Institute workers had done. This formula has no theoretical background. For most ordinary values of P and T it is closely proportional to the cruder P/T. There is an implicit assumption that T is a measure of E.

Thornthwaite has now computed the loss of water to the air in several catchment areas (namely the difference between rainfall and run-off) and in several irrigated districts in the dry West of U.S.A. His latest formula is derived from these results. It is just as empirical as before, only far more complex; he says with truth that it is "completely lacking in mathematical elegance."

(1) New relations are set out for calculating "potential evapo-transpiration" from the monthly temperatures. This "potential evapo-transpiration" is the sum of all water losses to the atmosphere from plant and soil, when the soil is kept constantly supplied with water and covered with a crop or forest; the particular crop is immaterial. This appears to be another estimate of the evaporation of free water, which in Australia has commonly been measured from standard tanks. There are two steps in this calculation; (a) the

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derivation of Et* from temperature data; (b) a correction of this monthly figure for hours of daylight.

(2) The new analysis also allows for the storage in the soil of the previous months' rain, up to a limit of four inches.

The formula for 1 (a) is intricate, and calls for the use of tables and a nomogram. However, it may be simplified into the following form:

Monthly Et=4.4S+(T—m) . . . (*1*)
where the evapo-transpiration Et is measured in millimeters, S is the saturated vapour pressure at the temperature T of the particular month, and m is the annual mean temperature, both T and m being measured in fahrenheit. This simple formula agrees with Thornthwaite's for Bourke, Brisbane, Canberra, Melbourne, Mildura, and Sydney; the only departures of as much as 10 per cent. are for some winter months, and here the simple formula gives the more plausible results (see below). The simple formula also agrees well with some of Thornthwaite's North American stations, especially if we make the second term 1.2(T-m). An exact agreement would not have much point, since Thornthwaite's formula was derived from rough graphical methods in the first place. An alternative simplified version of Thornthwaite giving almost identical results in Australia, again with T in fahrenheit, is that evapo-transpiration in millimeters

$$= T + 0.04T\ (T\text{-}65) + (T\text{-}m)$$

or $Et = T + 0.04T\ (T\text{-}65) - 2\ (m\text{-}T)$

using the first form for T-m positive, and the second for T-m negative. The middle term is used only when T exceeds 65.

The Et for any month is made to depend on two things. Firstly, the temperature of that month; secondly, its departure from the mean *annual* temperature. The correction (T-m) must be *subtracted* for the cooler months. That is, if the month's temperature is 65°, then it will have a higher Et if the annual mean is 55° than if it is 65°, and higher still than if the annual mean is 75°.

This sounds senseless. How can today's loss of water be reduced by the fact that the weather will be hotter three months hence? Thornthwaite merely states that it is so, and leaves it like that. One explanation of his success in North America might be as follows. The formula only uses temperature and does not directly refer to humidity. Now the moist or maritime climates have a small range of temperature through the year, while the drier continental climates have a large range. Thus the range of temperature during the year (or continentality) is itself a measure of evaporating power. This accounts for the higher values in a continental summer, though not for the lower values in winter. On the other hand, a simpler explanation might do. Perhaps this correction for summer and winter is needed only because the correction for the hours of sunlight (given below) was too small.

1 (b) The corrections for length of day depend on the month, its number of days, and the latitude. For example, Adelaide at latitude 35° has a factor of 1.25 for December and 0.82 for June. Thornthwaite supplies a table of this factor. All subsequent "Thornthwaite" figures in this article include this factor. Incidentally, the same corrections might well be applied to the attempts to calculate evaporation from saturation deficit; it has long been found that the ratio E/s.d is low for the short-day months of March and April, and high for the long-day months of November and December.

Some Australian Figures

Some winter figures calculated by Thornthwaite's method look strange. Take his results for July in Alice Springs as against Sydney. The mean temperature is the same in both towns (52.8°). But Alice Springs has a hotter summer, and therefore his formula demands a

*The symbol Et is used in this article for computed evapo-transpiration after Thornthwaite; E is used for evaporation from a tank, whether measured directly or estimated from the saturation deficit.

lower evaporation in winter, namely 71 points against 106 for Sydney. Compare the tank evaporimeter figures, 142 and 71 points respectively—which are what one would expect, the respective saturation deficits being 0.20 and 0.10 inch. The use of the simple formula (*1*) quoted here lessens the error and gives 102 points for Alice Springs against 118 for Sydney; but the results are still in the wrong order. This discrepancy (71 against 102) is relatively the greatest observed between the original and the simplified formula and is an argument in favour of the simple form though, of course, the total differences are small. It is more useful to consider the results of the hotter months, and not be too critical of the strange figures for winter.

Thornthwaite's calculated figures for the hotter months are much lower than Australian evaporimeter readings, and the ratio of the two values is very variable. For example, the respective figures for Brisbane and Perth in January are: Thornthwaite, 5.5 and 5.1 inch; evaporimeter 6.7 and 10.3 inch. (Compare the saturation deficits, 0.33 and 0.40 inch; the respective mean wind velocities are 7 and 10 m.p.h.) If Thornthwaite is right, then our evaporimeter readings are merely misleading.

We come next to the detailed attempt to answer, how long is the growing season? Thornthwaite's method will here be compared with the earlier method followed at the Waite Institute, namely, P-E/3 is effective, or P-7s.d. is effective. Thornthwaite's test is much the more stringent for any one month, since he demands that P-Et shall be positive, and his Et is much greater than E/3 though less than E. At the same time, his test is less stringent for a long wet season, since he allows up to 4 inches to be carried over from one month to the next.

On the first point, consider the start of the season in Burketown (Queensland). Burketown in December has a mean temperature of 85.4, a Thornthwaite Et of 7.2 inch and a rainfall of 4.8 inch. It counts, therefore, as a dry month, with a deficit of 2.4 inch. On the other hand its saturation deficit is 0.5 inch, so P-7s.d is positive, with a surplus of 1.3 inch. The two formulae give flatly opposite results. It should be noted that for both methods a "dry month" is one during which plants suffer from drought, not necessarily one of no growth. Thornthwaite's expression is "water need." To get rid of such large amounts of water as the 4.8 inch reckoned by Thornthwaite for Burketown in December transpiration by growing plants must be large; so much water could not all be lost by evaporation from soil. The reason why this formula is more stringent than that of the Waite is merely that he includes and emphasizes transpiration by plants while the Waite estimates only evaporation from soil.

The second point, the carry-over, is admirable and is best shown by an example. The following figures are for Rutherglen (Victoria) expressed in inches:

	MONTH								
	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Thornthwaite Et ..	2.1	1.2	0.6	0.7	0.9	1.6	2.5	3.3	3.6
Rain	1.3	2.0	2.8	2.2	2.2	2.1	2.1	1.4	1.8
Water in soil	0.0	0.8	3.0	4.0	4.0	4.0	3.6	1.7	0.0
P—7s.d.	+	+	+	+	+	+	+	—	—

The total storage allowed in the soil is four inches. (Of course some soils will hold more and some less.) Anything over this allowance appears as drainage or run-off. By using this storage November has a positive figure in spite of the

deficit of 1.9 inch on its own account. Thus the Thornthwaite formula gives a seven-month season from May to November. The Waite formula, with its less stringent test for one month, but no allowance for storage, gives also a seven-month season, from April to October.

Some examples from Queensland where cropping is either attempted or established will illustrate the difficulties in applying Thornthwaite's formula in Australia. Clermont and Kingaroy are of interest for summer-growing crops. By this formula both centres have continual "water need" throughout the summer. The deficits in Clermont for December, January and February are 2.7, 1.3 and 1.9 inch respectively. Those for Nanango (used as a source of figures since those for Kingaroy are lacking) are smaller. By contrast, Roma and many other south-eastern towns appear by the formula to have a four-month season in the winter, the excesses of June and July providing water enough for maximum growth in August and September. As already pointed out, the formula under-estimates the loss of water to the atmosphere in inland Australia during the winter.

A map has been published[1] for Queensland showing the number of wet months using Thornthwaite's formula.

Place of Atmospheric Humidity

We have seen that Thornthwaite's formula for Et gives the same result for a dry Mediterranean summer (Perth) and a wet monsoonal summer (Brisbane) provided that the mean temperature is the same. But evaporation has long been known to be a function of the wind and the difference between the vapour pressure of the atmosphere and that of the evaporating body. What defence can there be for ignoring the atmospheric humidity? (We have unfortunately become used to ignoring wind, perhaps because data are scanty.)

The defence is that the classical formula has been dropped altogether on account of various practical and theoretical difficulties (this is not mentioned in Thornthwaite's article). The formula preferred is one for the intake of solar energy, which is potentially a source of a corresponding amount of evapo-transpiration. If the formula is merely one for heat-exchange, saturation deficit has no place in it. There is no proof, however, that the empirical formula found by Thornthwaite simply measures the intake of heat. As we have seen, this formula gives an Et proportional to the saturated vapour pressure (apart from a correcting factor), so that one cannot help coming back after all to the question, why ignore the actual humidity? Might not a humidity correction avoid such curious results as those quoted for Brisbane and Perth?

Sanderson's experiments at Toronto[2] throw some light on the problem. She used a Thornthwaite evapo-transpirometer by which the daily loss of water from a tank of cropped soil was automatically replenished and measured. It was thus possible to check the daily experimental figures against those estimated by Thornthwaite's formula and by the formula E (daily)=0.7s.d. The saturation deficit is estimated from mean temperature and mean relative humidity, and is corrected for latitude from Thornthwaite's tables. The days in the table are the only ones for which full figures were published.

DATE	July 31	August 1	August 2	August 11	August 12
Mean temperature	58	57	64	75	82
E (from s.d.) mm.	3.8	4.6	4.0	4.0	7.3
Et (Thornthwaite) mm.	2.8	2.7	3.5	4.7	5.6
Et (measured) mm.	5.3	4.9	4.1	3.7	3.6

On the windless humid August 12, both calculations are too high; but apart from this day the results favour the use of saturation deficit. This is especially so on the first two days when the cool but dry north-westerly was blowing. A correction for wind would have further improved the advantage of the saturation-deficit formula, but this is not under discussion here.

While the day-by-day figures calculated by Thornthwaite's formula appear misleading, the month-by-month figures for Toronto agree with the experimental values. The process by which errors of opposite signs have cancelled one another might be interesting to pursue. The agreement of the calculated and experimental monthly values does not help much in forming a judgment, since climates resembling that of Toronto were used in devising the original formula.

Acknowledgment

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References

1. Dyne, R. E., *Economic News* (Queensland Bureau of Industry) 18, No. 31, 1949.
2. Sanderson, M., *Canadian J. Res. C.*, **26**; 445, 1948.
3. Thornthwaite, C. W., *Geog. Rev.*, **38**: 55, 1948.
4. Trumble, H. C., *Trans. Roy. Soc.* S. Aust., **61**: 41, 1937.

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FIELD SURVEY OF A PRIMARY INDUSTRY

By P. S. LANG

Surveys of primary industries are nowadays rather fashionable, and the experience gained from about three years spent on a field-interview survey of the sheep industry in the Western District of Victoria may be useful to other practitioners of this craft. The virtue of any survey rests heavily upon the initial planning, in all stages of which it is most necessary to have a clear mental picture of subsequent stages. This is often extremely difficult but can be facilitated by acquaintance with the experience of others.

The Plan

The object of the survey must be clearly and concisely defined, not only to ensure correct planning, but because it will have to be enunciated to farmers and others on countless occasions, and must carry conviction if their support is to be forthcoming.

The technique of the survey is a matter for early decision. In the survey upon which these remarks are based, the data were collected by a personal visit to each sample member, but other methods are available.[1] Preliminary decisions are required regarding the desired characteristics of the sample, the method of sampling, the number of workers, the type of data to be collected and the method of recording and analysing it.

Fitting the survey into the period available is a difficult matter. In the survey concerned, roughly as many man-months were spent by the research staff in collation and writing the report as in collecting the data, while approximately one-tenth of the total were occupied in preparatory work and selecting the sample. If,

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for instance, this is from a population stratified on the basis of flock size or breed of animal, it is desirable to complete the collection of data not later than a year after sampling begins. The longer this period, the larger the proportion of sample units which, when actually visited, will prove to have changed in breed or size since the time of sampling. A bush fire or drought may decimate flocks, properties may be subdivided or added to, or farmers may change from wool to meat production or vice versa. Moreover, it will probably be desirable to refer all details to a common date, and the greater the lapse of time between this and the date of visit, the more difficult it will be to obtain accurate information.

Sampling

The survey mentioned involved visiting 150 members of a stratified random sample of farmers in an area roughly 160 miles long and 60 miles wide. The first step towards sampling such a farming population is to learn as much as possible about it and the area concerned—the distribution of farms according to acreage of farm or size of flock or herd, their density in different parts of the area, variations in methods from one part to another, and the natural subdivisions of the area based on climate, topography, geology and soil. This may conveniently be done by a reconnaissance survey, involving casual visits to farmers and discussion with stock and station agents, assisted by a detailed examination of production statistics. The "sampling unit" should be clearly defined —whether flock, farm or farmer. The actual basis for sampling is a matter for expert statistical opinion to suit each individual survey, and generalised remarks here would be of little value.

Questionnaire

Having decided the main topics to be discussed with each farmer, their sequence comes under consideration. Experience indicates that it is generally feasible to enter up the questionnaire in the presence of the farmer. If this technique is to be used the questions should be set down in an order which allows questioning to proceed in a conversational manner. For example, it is better to commence an interview with familiar and harmless subjects such as the rainfall and the type of stock, rather than in a merciless attempt to record the last year's income and the extent of indebted ness. If, however, the questionnaire is to filled in after the interview, logical sequence may be subordinated to the requirements of the system for coding the answers. If a formal coding system is to be used it is emphatically desirable to plan it at the same time as the questionnaire, and to make the latter conform to its requirements wherever possible.

The object should be to make coding require the minimum of judgment, and ideally the answers to questions should be obtained in an appropriate sequence and in stereotyped forms so that they may be recorded in the questionnaire merely by a tick opposite the appropriate symbol. For instance, the 150 farmers in the Western District sheep survey, gave 32 more or less different reasons for choosing their respective lambing dates. A good deal of time was required to reduce these to the 10 main underlying reasons as a preliminary to sorting and tabulation. But if the 10 main possible answers to the question are already set down—with space provided for "Other"—most replies can be recorded rapidly and fairly accurately. This, however, is extremely difficult to arrange unless the probable range of answers is known before the survey begins.

A pilot survey is a partial solution and has the added advantages of indicating the actual questions which should be asked, and those to which one can expect to get answers. It also enables the best phrasing of questions to be determined, so that they can be printed in the questionnaire in the exact form in which they are to be asked. Thus all farmers are asked each question in a similar manner. Such a pilot survey involves testing a draft questionnaire on some farmers outside the sample,

but engaged in the type of production to be examined. Data gained from them should be coded and analysed right to the stage of tables showing the numbers doing this or that. Experience so gained can then be used to modify the draft questionnaire. The final version should be rigidly adhered to during the survey proper.

Perhaps the most difficult of all tasks in questionnaire preparation is limiting the number of questions to be asked. It has been found practicable to spend up to 8 hours on each property, of which up to 4 were spent filling in the questionnaire. A questionnaire which takes 4 hours to complete is uncomfortably long for both farmer and survey party, and only one can be completed per day. On the other hand the advantages of covering only one property per day are that a more thorough impression of the physical characteristics of each can be obtained, and if any data have to be memorised till the evening there is less likelihood of confusing the details of two properties.

Approach to the Farmer

An effective method of approach is an introductory letter from the director of the survey describing its objects and emphasising that information supplied will be treated as confidential. When the survey party is in the field a preliminary telephone call to arrange a suitable date and time is most helpful if an interview of more than an hour is involved. It also allows a description of the route to the property to be obtained.

Procedure in Collecting Data

An effective procedure during a visit to a property was found to be as follows:—

(*a*) General inspection under the guidance of the farmer. This is obviously desirable in order to inform the survey personnel about the characteristics of the property, but it is also valuable in allowing all concerned to become acquainted with each other before the second stage is reached and the questionnaire is produced.

(*b*) Questioning, and recording of answers. For this to proceed effectively the farmer requires to have gained some degree of confidence in the visitors. If the survey is of a general reconnaissance type, or merely involves noting answers to a short series of questions, individuals can effectively work singly. But if the questionnaire is long and involves standardised questions, one worker is likely to have considerable difficulty in putting questions, conducting the discussion and recording data. An effective system would then involve a questioner and a recorder. If a third member is available he can use the time taken by the interrogation for an inspection of soils and pastures.

(*c*) Writing up questionnaire. Completion and checking of questionnaires should be done each evening. A map of each property showing subdivision, soil types, pasture types, shelter belts and water points is useful in subsequent stages, and its construction is facilitated by aerial photographs if these can be obtained. These also help to gain the farmer's interest.

Analysis of Data

Two main methods of sorting and tabulation are available.

(*a*) By hand. If on a large sheet of squared paper each property is allotted a horizontal line, and each question a column, each farmer's answer to each question can be recorded by a code letter in the appropriate square, and the letters can be subsequently totalled and decoded. It may be desirable to arrange the properties on the sheet in groups according to size of farm, breed of animal, etc. This manual method is laborious, but may be the better if the sample is relatively small. It has the advantage that answers need not be recorded in a standard form since the coding system can be expanded as fresh variations in answers are encountered.

(*b*) By machines, e.g., Hollerith or Powers machines. These automatically

tabulate from special cards data which have been punched in coded form. They are best used when the sample is large and questions are relatively few. When the reverse is the case a disproportionate amount of labour and expense may be involved in setting up the machines for each operation. Mechanical sorting and tabulation has the advantage that quite complex relations can be obtained far more easily than by hand. For example, a tabulation may be made showing for each climatic zone of an area, the number of flocks of Merinos which run on properties with more than 20 per cent. improved pasture. To get this result by hand is very tedious. It should be pointed out that unless the sample is large, the final number of flocks in each group after several such sub-divisions may be too small to be statistically significant. In the Western District survey no more than two subdivisions were ever made.

A simpler mechanical method may well be the most effective system for handling a large number of answers from a hundred or so properties, but no experience can be quoted. This is the system whereby punched cards are sorted into groups by passing a needle through the appropriate holes, after which the number in each group is counted. However, neither this nor the automatic method can be applied until the system of coding has been completed.

Finally, experience suggests that one cannot expect to get effective replies to all questions from all sample members when the experimental material and the subject being studied are so variable. Some shortcomings are inevitable, but a farm survey can still give a most valuable picture of the industry concerned.

Reference

1. Rowley, Sheila, *J. Aust. Inst. Agric. Sci.*, **12**; 14-21, 1946.

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TECHNICAL PAPERS

A MAPPING SYSTEM FOR THE COMPILATION OF A SOIL MAP OF AUSTRALIA

A System Based on the Taxonomy of the Great Soil Groups

By C. G. STEPHENS

Soil Maps of Australia and Various States and Regions

A number of soil maps of Australia or significant portions thereof have been compiled since the first map of the continent was produced by Prescott[3] in 1931. This early map showed ten categories termed major soil zones, and was published on a scale approximating one in nineteen million. In 1934 a map of the soils of Tasmania was produced by Stephens.[7] This showed six categories and one combination of categories composed principally of Great Soil Groups—some subdivided and some combined; the scale approximated one in three million. A regional classification of the soils of Western Australia was issued by Teakle[9] in 1938. This showed soil zones, related to Great Soil Groups, subdivided into soil and ecological regions, on a scale of approximately one in ten million. In 1941 Stephens[8] published a new map of the soils of Tasmania using thirteen mapping units of combinations or subdivisions of Great Soil Groups and enlarged the scale to about one in a million. This map was republished by the State Economic Planning Authority in 1947.

In 1944 Prescott[4] issued a new map of the soils of Australia on a scale of one in ten million using eighteen mapping categories composed of Great Soil Groups, combinations thereof and some natural geographic units such as "Tablelands and Ranges" and "Tidal Marshes and Deltaic Formations." This followed a similar map of the soils of Tropical Australia[5] published in 1941. A regional map of Queensland showing twenty-one classes based on soil, contour and vegetation, compiled by Whitehouse,[10] was issued in 1942 by the Australian Army on a scale of one in a million. In Victoria the State Regional Boundaries Committee issued in 1944 a map of that State compiled by Skene.[6] This showed twelve categories based on Great Soil Groups and their subdivisions on a scale approximating one in two million. In 1946 Christian, Stewart[1] and others compiled a map of the land systems of the Darwin-Katherine Region of the Northern Territory on a scale of approximately one in half a million. They mapped sixteen land systems which are based on soil, vegetation, topography and country rock. In 1948 Leeper[2] issued a soil map of Victoria on a scale approximating one in five million.

At the present time a number of soil mapping projects of a regional character are being undertaken in various localities, particularly by the field party of the North Australia Survey Committee on the Barkly Tableland and the Victoria River Downs.

Consequently it is appropriate to point out that it is desirable that the mapping units used, the scale of working and the soil classification used as a basis for map-

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ping units should be such that the work, when done, is suitable for use as a contribution to the mapping of the soils of Australia as a whole on a scale, say, of one in a million.

Numerous factors concerned with pedological studies, land development, soil conservation and the utilization of water resources point to the need for a comprehensive soil map of Australia on such a scale. Inspection of the above quoted maps and their accompanying literature reveal that for the most part they are unsuitable for such purposes. The principal difficulties are the frequently inadequate scales and the variation in the nature of the mapping units which range from true soil categories, simple and compound, to geographical units of various sorts and combinations. What is needed is a map based entirely on soil categories, founded on a sound system of classification and produced on such a scale that the detail presented on a small part of the map is applicable to a recognizable unit of country.

In the following chapters there are presented, first a soil classification based on morphological features and welded into a taxonomic whole; and second a system of mapping based on compound units derived from the classification and so designed that it is possible to show what are the dominant, subdominant and occasional soils in any particular area.

The Taxonomy of Soil Classification in Australia

Classification of natural objects is readily and soundly based on morphological features, that is, on those physical and related properties discernible to the human senses either directly or with the aid of simple scientific devices. Where the objects classified are the result of some natural process of development or genesis, the morphological features of the objects are in effect the present expression or endpoint of the genetic process. If in erecting a classification based on morphology it is possible to discern a correlation of the established classes with the mode and intensity of operation of the genetic factors then the degree of such genetic compatability of the units of classification is the best possible indication of their validity.

The property of genetic compatability was readily established for the morphologically recognized Great Soil Groups of Europe, and this has since been perceived clearly on all continents. Consequently, the Great Soil Groups are virtually the central pillar about which a taxonomic system has been erected—largely by American effort. General and detailed tabulations of the system as applied to Australian soils are reproduced here in *Tables 1* and *2* below.

TABLE 1

Classification of Soils.

A.—Soil	(a)	Differentiated soils (see Table 2).
	(b)	Undifferentiated soils—
		(α) Alluvial soils of little or no profile development.
		(β) Skeletal soils.
B.—No soil.	(δ)	Bare rock.

At the present time six categories—Types, Series, Families, Great Soil Groups, Sub-orders and Orders — are recognized in the taxonomic classification of soils. Depending on the size and nature of the area to be mapped and the purpose and scale of the finished maps, it is possible to map in the units of any category, either singly or in associations. Categories I, II and III are inapplicable in such a project as that outlined here because of the unduly large number of mapping units either singly or in associations which would be required to cover the continent. Category VI can provide only two units of differentiated soils giving with α, β and δ above five mapping units. This is an inadequate number. The Sub-orders of category V can provide only 7 plus α, β and δ, in all 10 units, to be used singly or in associations: this is still inadequate for a scale of one in a million. The 36 units of Category IV, the Great Soil Groups,

TABLE II

Classification of Differentiated Soils

A taxonomic arrangement of the various Australian Great Soil Groups known to exist

VI.—ORDERS	V.—SUB-ORDERS.	IV.—GREAT SOIL GROUPS (Automorphic, Hydromorphic, Halomorphic, Ferrimorphic, and Calcimorphic).
PEDALFERS.	Acid organic soils.	Moor Peats. Moor Podzol Peats. Swamps.
	Acid soils with organic and sesquioxide illuvial horizons.	Podzols. Meadow Podzols. Ground-water Podzols.
	Acid soils with sesquioxide and clay illuvial horizons.	Residual Lateritic and Sandplain—Podzols. Brown Podzolic Soils. Grey-brown Podzolic Soils. Red Podzolic Soils. Yellow Podzolic Soils.
	Acid to neutral soils with sesquioxide and clay eluvial and illuvial horizons.	Red Loams. Lateritic Red Earths. Lateritic Red Loams. Terra Rossa.
PEDOCALS.	Soils largely with neutral organic eluvial and neutral or calcareous illuvial horizons.	Black Earths. Chernozems. Rendzinas. Water-table Rendzinas. Fens. Solonetz. Solonchak. Soloth.
	Soils with neutral eluvial and calcareous illuvial horizons.	Brown Earths. Red-brown Earths. Brown Soils of Light Texture. Brown Soils of Heavy Texture. Grey Soils of Heavy Texture. Grey Calcareous Soils. Solonized Brown Soils.
	Soils with neutral to alkaline eluvial and calcareous and gypseous illuvial horizons—profiles deflated to varying degrees.	Desert Loams. Stony Desert. Desert Sandhills. Grey-Brown Calcareous Desert Soils. Red Calcareous Desert Soils. Desert Sandplain.

and α, β and δ, 39 in all, provide an adequate but not too voluminous basis for the map proposed.

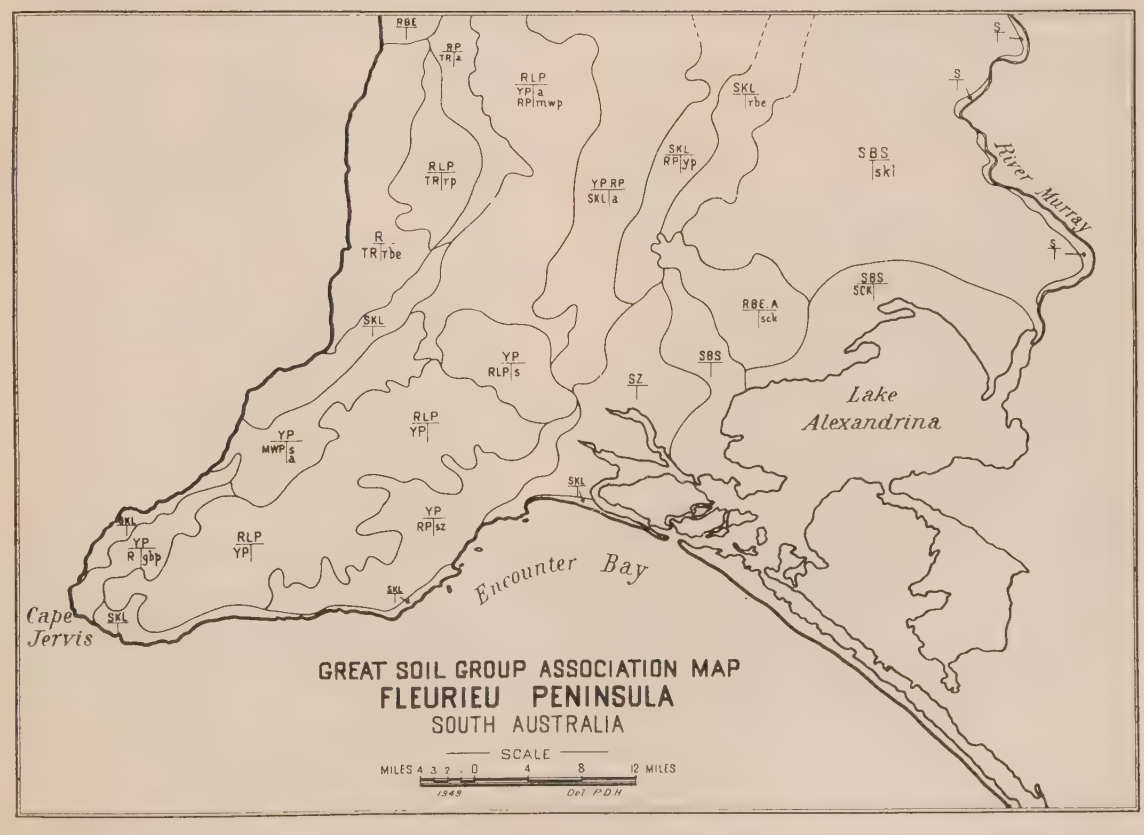
A soil map based on the Great Soil Groups will have a wider value than a land-use map, and in fact will provide a permanent basis for present and future land-use mapping as well as for other geographical studies.

If we accept one square inch of the proposed map as a reasonable sample of a particular region the area represented equals approximately 250 square miles, and it is the usual experience to find more than one Great Soil Group represented in such an area. Hence it will be necessary to map in associations of Great Soil Groups if the soil pattern is to be adequately represented. These associations can be defined in terms of relative dominance of the different soils and so give quite a detailed picture of any particular area. This is apparent from the sample map and proposed legend shown in the section dealing with mapping technique.

Mapping Technique

The following procedure is suggested:

1. Use County maps or other large-scale maps as working plans in the field.
2. Do not map individual units of less than 25 square miles.
3. In any area delineated determine which soil is dominant, which subdominant and which occasional. Sometimes soils may be co-dominant, sometimes exclusive. The type of map record required is illustrated in the sample map of approximately 2,000 square miles of Fleurieu Peninsula in South Australia. Such data will enable the compilation of a soil map on the multiple legend system using for each mapped unit a base colour and symbol for the dominant soil and symbols in black and of different sizes to show the sub-dominant and occasional soils.
4. Mapping should be done on the basis of traverses designed to work out the relationships of soils to climate, vegetation, relief, parent material and relict landscapes. The relationships established are then used to interpolate between traverses, aerial photographs



being used wherever available. Most traverses will doubtless be done along roads and probably average 10 to 20 miles apart, but either closer or wider traverses will be necessary in some localities.

Legend

Moor Peats	MP
Moor Podzol Peats	PP
Swamps	S
Podzols	P
Meadow Podzols	MWP
Ground-water Podzols	GP
Residual Lateritic Podzols	RLP
Brown Podzolic Soils	BP
Grey-brown Podzolic Soils	GBP
Red Podzolic Soils	RP
Yellow Podzolic Soils	YP
Red Loams	RL
Lateritic Red Earths	LRE
Lateritic Red Loams	LRL
Terra Rossa	TR
Black Earths	BLE
Chernozems	C
Rendzinas	R
Water-table Rendzinas	WR
Fens	F
Solonetz	SZ
Solonchak	SK
Soloth	SH
Brown Earth	BE
Red-brown Earth	RBE
Brown Soils of Light Texture	BL
Brown Soils of Heavy Texture	BH
Grey Soils of Heavy Texture	GH
Grey Calcareous Soils	GC
Solonized Brown Soils	SB
Desert Loams	DL
Stony Desert	SD
Desert Sandhills	DS
Grey-brown Calcareous Desert Soils	GCD
Red Calcareous Desert Soils	RCD
Desert Sandplain	DSP
Alluvial Soils (undifferentiated)	A
Skeletal Soils	SKL
Rock	RK

Written out in full the legend would show the symbols used for dominant, subdominant and occasional for each soil category.

As an example if a green colour is assigned to Meadow Podzols then an area on the map with a green base colour on which appears the symbol—

$$\frac{\text{MWP}}{\text{R} \mid \begin{matrix}\text{f}\\ \text{sz}\end{matrix}}$$

means that the area so designated is dominated by Meadow Podzols with subdominant areas of Rendzinas and occasional Fens and Solonetz.

Colours could be assigned to each of the 39 soils, but this would involve a very complex lithographic process. Alternatively, 10 colours corresponding to the 7 Sub-orders and a, β and δ could be used. This would simplify the lithography and enable the map to be readily used as a Sub-order (zonal soil) map by reference to colour alone, as a Great Soil Group map by reference to the upper unit of the symbol and as a Great Soil Group Association map by reference to the full symbol.

Owing to the ultimate size of the map it would have to be produced in sheets some of which could be on a scale of one in a million and some one in two and a half million. The result would be an atlas of Australian Soils.

It is estimated that on a basis of 3,000,000 square miles there are 10 man-years' work involved.

References

1. Christian, C. S., Stewart, G. A., *et al.*, "Map of the Land Systems of the Darwin-Katherine Region, Northern Territory of Australia." Northern Australia Survey Committee Report (1946). (Mimeographed.)
2. Leeper, G. W., "Introduction to Soil Science." Melbourne University Press (1948).
3. Prescott, J. A., "The Soils of Australia in Relation to Vegetation and Climate," *Coun. Sci. Ind. Res. (Aust)., Bull.* No. 52, 1931.
4. Prescott, J. A., A Soil Map of Australia, *Coun. Sci. Ind. Res. (Aust)., Bull.* No. 177, 1944.
5. Prescott, J. A., and Skewes, H. R., An Examination of Some Soils from Tropical Australia, *Trans. Roy. Soc. S. Aus.* 65 (1): 123-137, 1941.
6. Skene, J. K. M., "Distribution of Soil Types in Victoria." State Regional Boundaries Committee (1944).
7. Stephens, C. G., Notes on a Soil Map of Tasmania, *J. Coun. Sci. Ind. Res. (Aust).*, 7 (2): 107-109, 1934.
8. Stephens, C. G., The Soils of Tasmania, *Coun. Sci. Ind. Res. (Aust)., Bull.* No. 139, 1941.
9. Teakle, L. J. H., A Regional Classification of the Soils of Western Australia, *J. Roy. Soc. W. Aus.* 24: 123-195, 1938.
10. Whitehouse, F., "Regional Map of Queensland," First Aust. Army. Maps No. 44/1-6 (1942).

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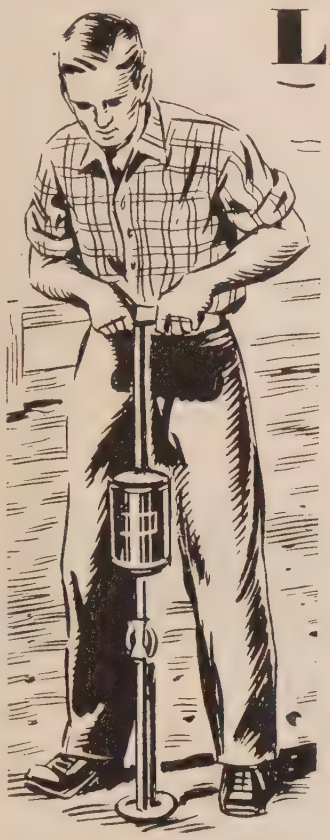

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RED AND BROWN HARD PAN SOILS OF WESTERN AUSTRALIA

By L. J. H. TEAKLE

One of the many puzzles in soil genesis presented by the soils of Australia is that of the red and brown hard pan soils of Western Australia. These soils have been described by Teakle.[2] At the time, no convincing suggestion as to their genesis or interpretation of their peculiar properties was made, and none has been forthcoming in the intervening years. It is now postulated that the hard pan of these soils is the "billy," or silicified layer, exposed by the truncation of a laterite profile. The present soil is forming on this intractable material, and may have been forming for a very long time.

These soils are generally of medium texture—sandy loams to sandy clay loams—red, red brown and brown in colour—and show little profile differentiation above the siliceous hard pan. Many examples of these soils have a stony surface, or desert pavement. In these cases, stones are usually found throughout the soil above the hard pan. It appears that these stones are formed largely from a mechanical break-down of quartz rocks and of a material referred to as quartz-hæmatite duricrust.

The hard pan is encountered at variable depths, usually ranging from about 6 inches to 3 feet, but sometimes quite deep. It is a laminated formation, the layers being generally 1 to 2 inches thick and horizontally disposed. Reports and observations indicate that this hard pan ranges in thickness from just a few feet to over a hundred feet. It is said to be generally 30 to 40 feet thick. The colour ranges from brown to red, but the surfaces of the layers are often stained black, due to deposition of manganese oxides. The upper parts of the hard pan layers are typically not calcareous. However, near the western and southern boundaries where these soils contact the brown solonised soils, and where the Eastern York gum *(Eucalyptus lucasi)* is a general feature of the woodland vegetation, infiltration of calcium carbonate has occurred, and is commonly observed as a deposit on the surface of the layers. Kaolinised material is observed below the hard pan at least in some profiles. The writer has too little evidence to give an opinion as to whether this is a general or an unusual feature.

Treatment of the hard pan material with hydrochloric acid removes the colouring agent, which is undoubtedly iron oxide, and leaves a white sandstone. This disintegrates on treatment with hydrofluoric acid to yield a sand.

The soil above the hard pan is generally acid in reaction, the pH distribution being as follows:

	Range of pH value					
	Below 5	5–6	6–7	7–8	Above 8	Total
Number of Samples	7	13	7	9	2	38

Calcium and magnesium dominate the metallic cation complex. Soluble salts are very low.

These hard pan soils dominate at least three soil regions[3] in the west central portion of Western Australia between Longitude 115°E. and 124°E. and Latitude 23°S. and 30°S. The area approximates 200,000 sq. miles. See *Fig. 1.*

The present climate is arid, the average annual rainfall being only 8 to 10 inches without marked or consistent seasonal incidence. There are two periods of maximum precipitation, February-March and May-June, when the average rainfall

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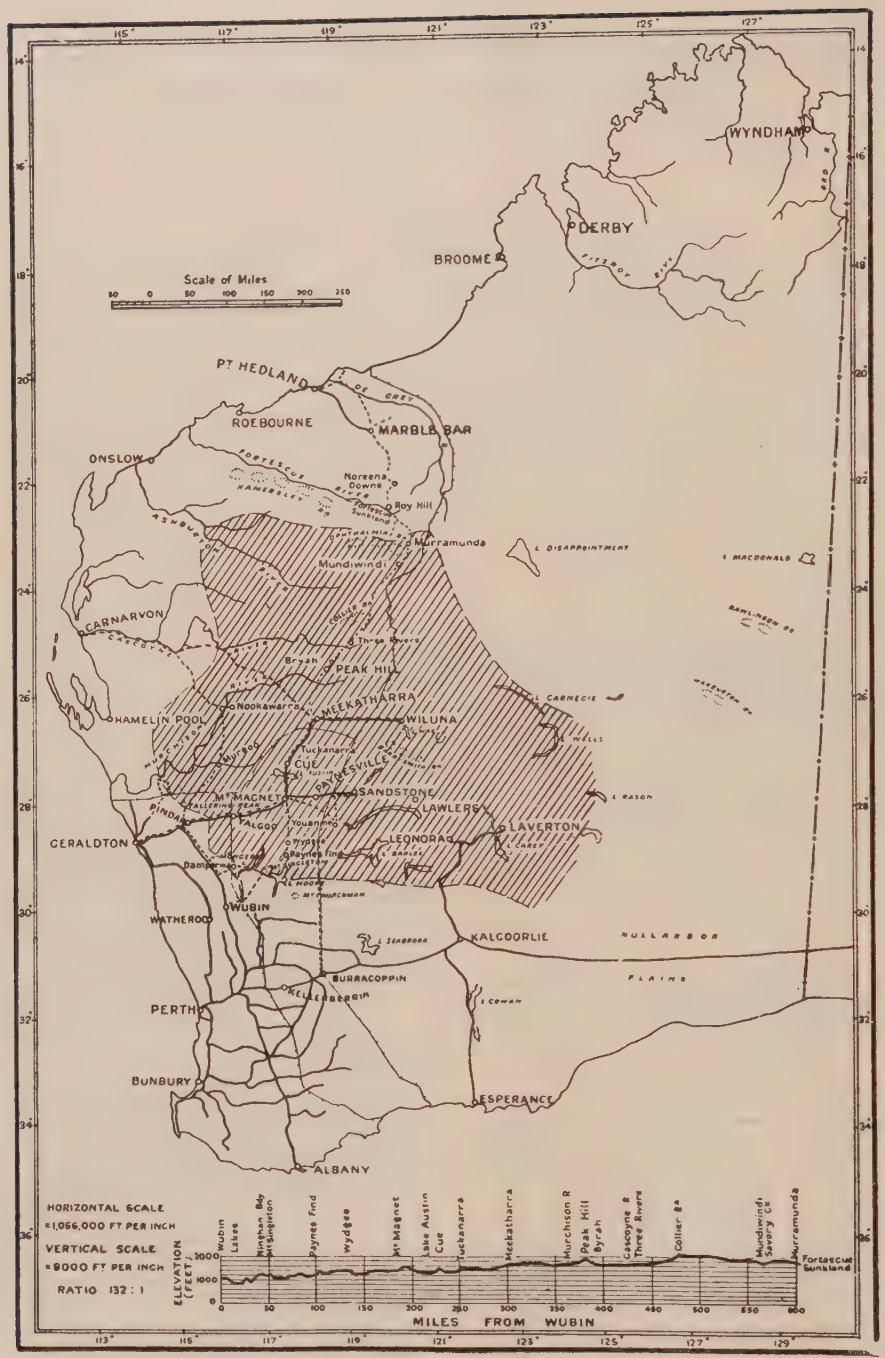

Fig. 1.

Map of Western Australia showing the location of the red and brown hard pan soils of the Acacia semi-desert scrub. The section at the bottom of the figure is based on aneroid readings (J. Agric. West. Aust. Vol. 13, p. 481, 1936).

somewhat exceeds one inch per month. A considerable proportion of the rain comes in heavy falls of several inches which often cause widespread floods. The summers are hot and dry. Maximum temperatures frequently exceed 100°F., and

the relative humidity is very low. The winters are cool and bracing. Annual evaporation approximates 100 inches and the Meyer ratio of 24 indicates desert conditions.

The vegetation is largely an acacia scrub commonly referred to as mulga. True mulga *(Acacia aneura)* is but one constituent of the association in Western Australia, and does not dominate the vegetation as is the case in this vegetation region in Queensland. On the southern south-western boundaries of the area, cypress-pine *(Callitris glauca)* frequently dominates the vegetation association.

These soils are formed on a variety of geological horizons ranging from pre-Cambrian to Tertiary in age. The present land surface is derived from the dissection and truncation of a more ancient plateau, and now appears as a new plateau from 1,000 to 2,000 feet above sea level. This new plateau, now in process of formation, consists of broad, relatively level and featureless valleys broken by isolated hills and ridges, relics of the old plateau which was formed under an earlier cycle of erosion. The courses of the streams are shallow and poorly defined. In times of flood the rivers break their banks and the waters spread for miles over the level plains.

Obviously, the characteristics of these soils are not in keeping with the present climatic factors which are very definitely of the arid type. Many of the features must have been inherited from a bygone age. This hypothesis is in keeping with the present opinions regarding certain other groups of soils in Australia. It is well recognised that much of Australia was once covered by a laterite surface, probably formed in Pliocene times. It is a common feature of the residuals of the old plateau which are observed in many parts of Australia. The features of the laterite profile and the effects of denudation have been described by many writers including Whitehouse[4] and Stephens.[1] The essential features of a laterite profile are the laterite proper which is a zone of accumulation of sesquioxides in vesicular and other forms, and the translocation of silica. In many places the migrating silica is deposited below the laterite proper and cements the underlying material to form "billy."

As stated above, it is suggested that these hard pan soils are forming on the "billy" horizon of the laterite where the laterite has been truncated. This truncation has occurred in the formation of the "new" plateau. In the course of soil formation the "billy" has been impregnated with oxides of iron to give a brown or red colour.

The hypothesis that the Western Australian hard pan soils are forming on the "billy" layer of a laterite profile was suggested by observations in the mulga country of south-west Queensland where the soils have certain features in common. These soils, also, are thought to be developing on the "billy" where the upper portions of the old laterite formation have been removed.

Acknowledgment

Grateful acknowledgment is made for the permission of the Director of Agriculture, Western Australia, to use the block for Fig. 1, originally published in the Jour. of Agric., Western Australia, Vol. 13, p. 481, 1936.

References

1. Stephens, C. G., "Pedogenesis following the Dissection of Lateritic Regions in Southern Australia," *Coun. Sci. Ind. Res. (Aust.) Bull.* No. 206, 1946.
2. Teakle, L. J. H., "The Red and Brown Hard Pan Soils of the Acacia Semi-desert Scrub of Western Australia," *J. Agric. West Aust.*, **13**: 480-493, 1936.
3. "A Regional Classification of the Soils of Western Australia," *J. Roy. Soc. West. Aust.*, 24: 123-195, 1938.
4. Whitehouse, F. W., "Studies in the Late Geological History of Queensland," *Univ. of Queensland, Papers in Geol.*, 2(1): 2-22, 1940.

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BIRDS AS A BIOTIC FACTOR IN THE ENVIRONMENT OF PASTURES WITH PARTICULAR REFERENCE TO GALAHS (Cacatua Roseicapilla)

By G. H. ALLEN

I.—Field Studies, *"Gilruth Plains," Cunnamulla, Q.*

Introduction

The present-day trend towards extension of agriculture into the near-western grazing lands of Queensland has prompted the compilation of some data concerning seed-eating birds and their likely influence on crops and pastures.

During the course of pasture investigations at the C.S.I.R.O. National Field Station, "Gilruth Plains," near Cunnamulla, the presence of large flocks of birds which fed avidly on seeds on the open plains, had suggested a possible effect, due to reduction of the seed supply, on the regeneration of both annual and perennial pasture species, particularly after long periods without rain.

There are two species likely to be of consequence. One is the budgerigar *(Melopsittacus undulatus)*, and these small birds, although present at times in flocks of tens of thousands, are migratory, and only appear occasionally on the south-western plains. Their habits would make it exceedingly difficult to assess quantitatively the actual amount of seed removed. The other species is the galah or rose-breasted cockatoo *(Cacatua roseicapilla)*, and they are of much greater importance. This ubiquitous western species in numerous flocks varying from thirty to several thousand birds (see *Figs. I and II)* feeds almost entirely on the open plain country except during those periods when grass seed is limited when they seek the pods of the Acacia scrubs, mulga, gidgee and ironwood. In view of the quantities of seed removed, and as such information has not previously been published, the available data has been presented in this paper.

Investigations

The investigational work consisted briefly of the following sections:—

(a) The amount and types of seed collected daily by galahs.
(b) The bird population.
(c) Remarks on bird weights and sexes.

(a) The Amount and Type of Seed Harvested by Galahs

Method

Birds were captured over a period and at different times of the day, but mainly before and after the daylight feeding period. The various organs of the alimentary tract were removed, and the contents separated, washed and dried. Dry weights were recorded. For seed counts a sub-sample of approximately 10 per cent. was treated. Determination of the main seed constituents was easily managed after previous experience, and the species occurring less commonly were grouped as "Miscellaneous."

Daily Consumption and Crop Contents.

The obvious method for arriving at a consumption rate for each bird was to examine the contents of the ingluvies (crop) after a specific feeding period. This was done in most cases after a full day's feeding, the birds being shot when they returned to camping sites in the late evening. In one case a bird (No. 8) was taken

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after two hours' feeding on the plain country, and several were taken early in the morning before the flock left for the feeding grounds.

One of the problems appeared to be the reliability of the figure for crop contents as an indication of the amount of seed collected during that particular day. Primarily it was essential to ascertain that the crop was emptied overnight, and this was done by examination of those birds taken early in the morning, and confirmed the belief as shown by results of birds 3, 4, 5, 9 and 10. A further study of the rate and distribution of seed throughout the digestive system was made, using a number of caged birds, and this trial is described under Section II.

In *Table I* the weight of crop contents together with total seed counts are given, the date of sampling and other details also being included. These subjects were examined over varying seasons, from times of fair seed supply to periods of seed shortage as instanced by the low quantities present in birds 26 to 29. Actually these were examined immediately after rain, and the crops contained a reasonable amount of non-seed material such as fresh green shoots from herbs and even small green grubs. The groups taken later, Nos. 30 to 34, reflect the period of plentiful seed supply.

The variation in weights of crop contents to number of seeds present is due to the differences in species and the amount of non-seed material collected by the birds.

Species Contributing to Crop Contents.

To continue the study further it was necessary to ascertain the different types of seeds collected and throughout the period the dominance of Button Grass *(Dactyloctenium radulans)*, Flinders Grass *(Iseilema spp.)*, and Mitchell Grass *(Astrebla spp.)* was obvious. Only during short periods of the year such as flush summers when Pepper Grass *(Panicum Whitei)* is well forward or following win-

TABLE I

Contents of Ingluvies of Galahs

Bird No.	Date.	Period of Feeding.	Body Wt. gms.	Sex	Contents gms.	No. of Seeds.	Remarks.
1	22/5/44	Full day. 6.00 p.m.	309	F	9.57	18,787	Six pts. rain during day.
2	,,	,, ,,	321	M	9.45	19,200	Six pts. rain during day.
3	24/5/44	,, Nil ,, 6.00 a.m.	375	M	Nil	Nil	Taken before feeding commenced.
4	,,	,, ,,	305	F	—	2	Taken before feeding commenced.
5	30/5/44	,, 6.30 a.m.	353	M	Nil	Nil	Taken before feeding commenced.
6	,,	Full day. 5.30 p.m.	335	F	11.70	22,892	Warm, sunny day.
7	,,	,, ,, ,, ,,	310	M	9.70	17,446	Warm, sunny day.
8	27/6/44	Two hours. 9.00 a.m.	340	M	0.50	1,120	Feeding on plain for two hours.
9	6/7/44	Nil. 7.00 a.m.	278	M	Nil	Nil	Taken before feeding commenced.
10	,,	,, ,, ,, ,,	320	F	—	15	Taken before feeding commenced.
11	28/7/44	Full day. 6.15 p.m.	302	F	7.32	13,810	Warm, sunny day.
12	,,	,, ,, ,, ,,	320	F	5.96	8,191	Warm, sunny day.
13	,,	,, ,, ,, ,,	328	M	8.05	12,159	Warm, sunny day.
14	,,	,, ,, ,, ,,	332	F	5.43	419	With a lot of broken wheat.
15	,,	,, ,, ,, ,,	358	M	4.88	165	With a lot of broken wheat.
16	28/8/44	Full day. 5.30 p.m.	299	F	6.95	16,073	Warm day. Some green material.
17	,,	,, ,, ,, ,,	323	M	7.76	18,080	Warm day. Some green material.
18	,,	,, ,, ,, ,,	317	F	12.26	27,542	Warm day. Some green material.
19	,,	,, ,, ,, ,,	318	M	8.59	15,110	Warm day. Some green material.
20	,,	,, ,, ,, ,,	320	M	9.78	21,162	Warm day. Some green material.
21	,,	,, ,, ,, ,,	322	M	7.33	17,377	Warm day. Some green material.
22	28/9/44	Full day. 6.00 p.m.	327	M	6.37	17,301	Seed of herbage spp. common.
23	,,	,, ,, ,, ,,	337	M	4.78	20,187	Seed of herbage spp. common.
24	,,	,, ,, ,, ,,	300	F	5.77	17,110	Seed of herbage spp. common.
25	,,	,, ,, ,, ,,	380	M	5.83	23,687	Seed of herbage spp. common.
26	27/10/44	Full day. 6.30 p.m.	302	F	2.31	2,157	Herbage seed gone and seed in short
27	,,	,, ,, ,, ,,	296	F	2.53	5,304	supply. More rain has fallen to
28	,,	,, ,, ,, ,,	308	F	2.61	4,518	provide summer species and seed.
29	,,	,, ,, ,, ,,	364	M	4.48	8,220	
30	5/6/45	Full day. 5.30 p.m.	341	M	12.34	27,282	New seed present.
31	,,	,, ,, ,, ,,	326	M	13.21	26,025	New seed present.
32	,,	,, ,, ,, ,,	327	M	11.43	23,651	New seed present.
33	,,	,, ,, ,, ,,	355	M	13.42	24,529	New seed present.
34	,,	,, ,, ,, ,,	325	F	13.63	22,034	New seed present.

ter rains, are other species more prominent. In the latter case the rains may bury many of the grass seeds, but also provide a lot of small herbage seeds such as Bindyi *(Calotis hispidula)* which is well liked as instanced by its preponderance in the crop contents of birds 22 to 26 in *Table 2*. The number of seeds of each major species in the crops of a number of birds is set out in this Table.

number of birds various organs were examined, some prior to the commencement of a day's feeding and some from birds taken on their return to the camping site. The parts included the proventriculus or first stomach, the gizzard, the duodenum and small and large intestines. The result of these examinations is shown in *Table 3*.

From the results in this Table it is shown that normally there is no return of

TABLE 2

The Constituents of Crop Contents of Galahs

Bird No.	Date.	Seeds of Species Present.					Total No. of Seeds.	Weight of Crop Contents gms.
		Button Grass.	Flinders Grass.	Mitchell Grass.	Bindyi.	Miscellaneous.		
1	22/5/44	18,420	350	10	—	7	18,789	9.57
2	,,	18,900	278	7	—	15	19,200	9.45
6	30/5/44	22,280	560	—	—	52	22,892	11.70
7	,,	15,000	2,430	6	—	10	17,446	9.70
11	28/7/44	9,156	4,654	—	—	—	13,810	7.32
12	,,	5,359	2,832	—	—	—	8,191	5.96
13	,,	7,948	4,211	—	—	—	12,159	8.05
14	,,	224	195	—	—	Wheat	419	5.43
15	,,	70	95	—	—	Wheat	165	4.88
16	28/8/44	12,386	3,687	—	—	—	16,073	6.95
17	,,	13,933	4,147	—	—	—	18,080	7.76
18	,,	22,248	5,192	—	—	102	27,542	12.26
19	,,	9,519	5,591	—	—	—	15,110	8.59
20	,,	16,918	4,244	—	—	—	21,162	9.78
21	,,	11,600	5,777	—	—	—	17,377	7.33
22	28/9/44	3,487	1,856	—	11,958	—	17,301	6.37
23	,,	—	4,886	—	15,224	77	20,187	4.78
24	,,	646	—	—	16,442	22	17,110	5.77
25	,,	9	7,911	—	15,752	14	23,687	5.83
26	27/10/44	1,287	—	849	—	41	2,157	2.31
27	,,	3,758	—	1,546	—	—	5,304	2.53
28	,,	2,780	—	1,564	—	174	4,518	2.61
29	,,	6,300	—	1,531	—	389	8,220	4.48
30	5/6/45	25,074	—	2,105	—	103	27,282	12.34
31	,,	24,265	—	1,714	—	46	26,025	13.21
32	,,	17,424	—	5,227	—	—	23,651	11.43
33	,,	22,629	—	1,899	—	—	24,528	13.42
34	,,	19,126	—	2,908	—	—	22,034	13.63

From an examination of these figures it will be observed that the Button Grass is the main source of seed supply for galahs. The seed of Flinders Grass also contributes a considerable amount, while others, such as the Mitchell Grass and Bindyi burr, are eaten when available in quantity, and when the other more easily collected seeds are in short supply.

Distribution and Assimilation of Seed.

Having ascertained a figure for crop contents and the various types of seeds collected by the birds, the next step is to follow the passage of this material through the digestive processes to determine whether any whole seeds are excreted and returned to the soil. With a whole seed. The complete utilization of the seed eaten may depend upon the hardness of the seed and the quantity which has to be handled in a day. This suggestion is supported by an earlier single observation by R. Roe* who found that in a bird with crop contents of approximately 12 gms. consisting of some 28,367 seeds, some whole seeds were present in the last six inches of the alimentary tract and of the 87 seeds obtained only six per cent. germinated under laboratory tests. Other observations have indicated that when seed supplies are very plentiful a small amount of seed may pass through the birds intact.

*R. Roe, C.S.I.R.O. Memorandum, 1944.

TABLE 3

Contents of Digestive Organs of Galahs

Bird No.	Feeding Period	Ingluvies.		Proventriculus.		Gizzard.		Duodenum.		Intestines.		Large Intestines.	
		Wt. gms.	Seeds.	Wt. gms.	Seeds.	Wt. gms.	Seeds.	Wt. gms.	Seeds.	Wt. gms.	Seeds.	Wt. gms.	Seeds.
3	Nil	Nil	Nil		Not	Not examined.				—	Nil	—	Nil
1	,,	.0	2		,,	,,				—	Nil	—	Nil
5	,,	Nil	Nil		,,	,,				—	Nil	—	Nil
8	Two hours	.5	1,120	.33	665	.56	857	—	18	—	3	—	Nil
9	Nil	Nil	Nil	.54	225	1.23	227 stone 69	—	Nil	—	Nil	—	Nil
10	,,	.01	15	1.00	1,302	1.74	182	—	Nil	—	Nil	—	Nil
11	Full day	7.32	13,810	1.92	2,734	2.70	124	—	Nil	—	Nil	—	Nil
18	,,	12.26	27,542	1.55	2,975	2.41	609	—	Nil	—	Nil	—	Nil
26	,,	2.31	2,157	.37	188	.02	18	—	Nil	—	Nil	—	Nil

From the foregoing account it may be stated that the daily crop contents vary from 2.5 to 13 gms. of seed, and the seed numbers from 2,000 to 30,000, depending upon the availability of supplies.

Amount of Seed Removed.

It is shown in Section II of this article that the crop contents at the end of a day's feeding may only indicate fifty per cent. of the seed harvested by a bird during a full day. Thus the figures for crop contents may be doubled to provide a daily consumption rate. If arbitrary numbers are taken for bird population and assuming a daily consumption rate of 15 to 20 gms. of seed per bird a small flock of 100 birds would remove from 10 to 14 cwt. of seed per year. This figure is even more outstanding if 5,000 birds are considered when the consumption may be 25 to 35 tons of seed per annum.

Many of the natural pasture species are heavy seeding, and, apart from the grasses, the herbage plants such as Lambs Tongue *(Plantago varia)* and the *Compositeæ* and *Chenopodiaceæ* supply a considerable amount of seed in proportion to the plant weight.

As galahs are always present, and as droughts are also common, there must be long periods when the birds are short of grain. Over these periods they follow the seeding trees such as gidgee and mulga which may seed near bore drains even during drought periods, and also obtain some sustenance from wattles, such as *Acacia Victoriæ* and *A. Murrayana* on the sand ridges and the seeds of Cypress pine, the latter species often seeding through a droughty period. Following rain they eat quite an amount of fresh green shoots and seedlings of a number of herbage species. Frequently galahs are observed eating the seeds of wild paddy melons growing on the roadside and on small sand ridges.

An average ration for poultry consists of approximately 56 gms. of grain and a

similar weight of mash, hence galahs may be compared in regard to food intake at a rate of five galahs to one domestic fowl.

A point worthy of mention is the difference in methods of harvesting grain by these two bird families. The fowl would take in grain with glumes attached, but the parrot family, owing to the structure of the beak and tongue, can readily separate the caryopsis from the adhering outer coverings. A small quantity finds its way to the crop, but by far the greater amount is separated and ejected while the galah is harvesting its daily supply.

The cleanness of the seed as removed from the crop reservoir is illustrated in *Fig. 3.*

Fig. 1.
Portion of a large flock of Galahs.

(b) Galah Population

The galahs are gregarious creatures, and their habits are most likely influenced by availability of grain and water. Hence the determination of a static population is most difficult. In certain seasons large flocks of tens of thousands are common, while, at other periods, in the same locality, only small flocks of from 10 to 100 birds may be seen. A study was made of the flight of birds to their evening camping grounds, and the number passing over a one-mile stretch of fence recorded. Over a period the recordings for the hour preceding sundown were as follows:—

TABLE 4.
Birds Passing Over a One-mile Line in Hour Before Sundown.

Date.	No. of Birds.
20/7/44	504
21/7/44	123
22/7/44	867
24/7/44	344
29/7/44	428
31/7/44	967
8/8/44	302
15/8/44	190
25/8/44	209
5/9/44	438
12/9/44	429
2/10/44	2,628
23/12/44	191

These counts are so variable that an estimate of density cannot readily be formed, and as the birds seem to change their camping grounds fairly frequently a long-term study would be necessary before attempting a calculation of population. At one period large flocks of galahs flew over regularly every evening for approximately three weeks, in flights just before sundown and probably totalled over 50,000 each day. Large flocks are common on the plains especially in the early morning and late afternoon, and sometimes may extend in line for over half a mile at similar density to the part of the flock shown in *Fig. 1.*

Small groups such as illustrated in *Fig. 2* are common during the day when the birds are actively feeding.

Fig. 2.
Typical small flock of galahs on western plains. Over 300 birds capable of removing more than 30 cwt. of seed per year.

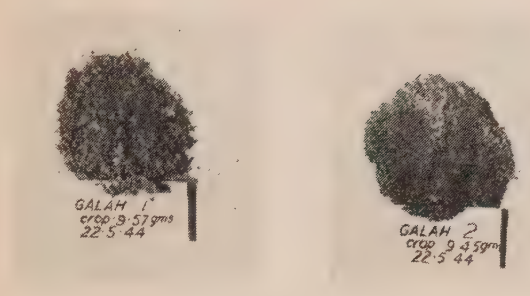

Fig. 3.
Seed as removed from the Ingluvies. Mostly Button Grass and only small quantity of glumes.

(c) Bird Weights and Sexes

The bird weights vary from 250 to 360 gms., the average weight being 320 gms., thus the daily seed intake is equal to five or six per cent. of their weight. There is a tendency for males to be slightly heavier than females. In the females, as with many bird species, only the left ovary is well developed. The sexes may be easily recognized by the eye colour, the males being all black while the females show a thin red circle towards the outer perimeter.

II.—Results of Cage Experiments with Galahs

In the preceding section consideration has been given to the quantity of grain and the types of pasture seeds consumed by the galahs and their numerical abundance in any particular area.

Indications of seed consumption have been obtained by examination of the ingluvies at the completion of a day's feeding. To show the relationship between the late evening examination of crop contents and the total amount of grain consumed this test was directed towards clarification of two points—

(i) Daily consumption rate of grain.

(ii) Rate of distribution and utilization of grain from the crop reservoir.

It has been shown in Section I that under normal circumstances the crop reservoir is empty in the morning and that the grain present in the evening represents parts of that particular day's harvest.

Method

Eight galahs were caged and fed a variety of grains for several weeks to allow them to quieten and become accustomed to captivity.

Prior to the commencement of the examinations all birds were fed lucerne seed for two days, and on the morning of the next day No. 1 was taken for examination before feeding. Wheat was then provided for the other birds and after three hours (6.30-9.30 a.m.) No. 2 bird was removed for study. At 1.30 p.m. after wheat had been available for 7 hours Nos. 3 and 4 were removed and the wheat replaced with panicum seed.

At 7.30 p.m. Nos. 5 and 6 were taken after panicum had been available for six hours preceded by wheat for seven hours.

At 7.30 a.m. of the next days birds Nos. 7 and 8 were examined after twelve hours during which time no seed was available. The birds were removed from the cage as quietly as possible and when two were taken an effort was made to select mates.

Results

(i) In the initial stages the birds consumed daily approximately 30 gms. of grain per head. This ranged from 42 gms. per head when on panicum and wheat down to 4.5 gms. per head when fed lucerne. The daily intake became more constant as the birds became quieter and, as stated earlier, settled down at about 30 gms. With pet birds as much as 57 gms. per head per day is allowed.

(ii) The examination of the digestive tract was made under the following headings:—

(a) Ingluvies.
(b) Proventriculus.
(c) Gizzard.
(d) Duodenum.
(e) Intestines.

With (d) and (e) it was found impossible to recognize the small fragments,

and, as no whole seeds were found, the contents of these organs have been excluded from the tabulated results. Material from each organ was washed and dried before weighing and counting of the component parts.

Details of the examination are given in *Table 5.*

period when only panicum was available. Some panicum had also been used from the crop reservoir. With the two birds a great difference was evident in the quantity of panicum each consumed, but still almost proportionate amounts of 12 per cent. and 15 per cent. had passed through to the proventriculus and with No. 6, 0.16

TABLE 5

Weight of Seed in Digestive Organs of Galahs (in Grams)

No.	Weight	Date.	Treatments.	Ingluvies.	Proventriculus.	Gizzard.
—		23-24/11/44	Lucerne.			
1	280	6.30 a.m. 25/11/44	Wheat given.	Nil.	.04 Lucerne.	No grain.
2	320	9.30 a.m. ,,	Wheat 3 hours.	6.45 Wheat.	.37 Wheat.	.01 Luc. .13 Misc.
3	260	1.30 p.m. ,,	Wheat 7 hours.	4.08 Wheat.	.93 Wheat.	.0 Wheat .15 ,,
4	370	1.30 p.m. ,,	Wheat 7 hours, changed to Panicum.	3.90 Wheat.	.88 Wheat.	.28 ,,
5	300	7.30 p.m. ,,	Wheat 7 hours, Panicum 6 hrs.	2.96 Wheat .15 Pan.	.68 Wheat .02 Pan.	.30 ,,
6	319	7.30 p.m. ,,	Wheat 7 hours, Panicum 6 hrs.	1.18 Wheat 4.0 Pan.	.10 Wheat .71 Pan.	.16 Pan. .13 ,,
7	302	7.30 a.m. 26/11/44	No grain for 12 hours.	.01 Panicum.	.03 Wheat .12 Pan.	.24 ,,
8	255	7.30 a.m. ,,	No grain for 12 hours.	.01 Panicum.	.23 Pan.	.12 Pan. .10 ,,

Miscellaneous consisted of ground-up grain and glumes.

Bird No. 1 indicates that at the onset of the test seeds fed during the previous day had all passed from the crop, and that only a trace amount was present in the first stomach.

Examination of bird No. 2 shows that the morning feeding rate is rather high, and that in a period of three hours the digestive process is well started, a quantity being present in the stomach and also in the gizzard.

In the case of Nos. 3 and 4 results indicate that the crop contents have decreased with some gain in the amount present in the proventriculus, and slight gain in the contents of the gizzard. It is probable that further movement from the gizzard has occurred and that the quantity present in that organ at any time is fairly low. This belief is supported by evidence from examination of birds shot in the field.

Birds Nos. 5 and 6 were examined later in the evening following a change of the grain available six hours earlier. Results show that a fair percentage of wheat had remained in the crop over the six-hour

gms. of panicum was present in the gizzard.

The amounts of seed present in the crops of these birds were low in comparison with those examined under field conditions. It is probable that the alarm created in removing birds for examination had adversely affected their normal behaviour.

The examination of birds Nos. 7 and 8 on the following morning showed that the crops were emptied with the exception of a few seeds retained in the loose folds of this organ when contracted. Small quantities of seed were present in other parts of the digestive system.

Discussion

(1) This test supports field observations which have indicated that the crop is emptied during each night.

(2) Movement of seed from the crop to the first stomach commences during the morning, and is probably a continuous process whenever grain is present in the crop. From the results no explanation can be found for the lower weight of wheat present in the crops of birds ex-

amined later than No. 2. The amount present in others during the day is rather low, and two possibilities are suggested.

The morning feed may be the main gathering for the day, and the unusual circumstances of the experiment may influence considerably the normal habits of the birds. Field studies have shown that under normal seasonal conditions galahs feed avidly early in the morning, then rest or fly around in timbered areas until a second feeding period in the late afternoon. The handling of the birds during the day would interfere with the evening feeding period. In the case of birds 3 and 4, although the crop contents suggested a decline, the amounts present in the organs of the digestive system showed an increase, due no doubt to maintenance of utilization of the grain from the crop.

(3) From the results of this test with lack of replication and the individual variations between birds only very general conclusions may be drawn. The amount of grain present at night as indicated by Nos. 5 and 6 was shown to be digested by morning in Nos. 7 and 8, although the night crop contents were considerably lower than noted in birds sampled when under field conditions. The cage experiment indicated that 5 gms. may be utilized overnight, whereas field tests have indicated that 10 to 12 gms. is a more general figure for the crop contents at dusk. Thus the test has not given quantitative evidence of the points desired. It has, however, shown that the daily consumption rate varies at different times of the day, and indicates that the utilization by digestion from the crop reservoir occurs whenever grain is present, and that the actual rate may vary according to the amount of grain present.

(4) From the examination of the lower alimentary tracts it has been shown that none of the grain fed were passed through the birds intact, and therefore there would be no return of collected seeds to the soil.

(5) The use of crop contents of galahs sampled at dusk as indicative of the daily feed is a distinct under-estimate. If 10 to 12 gms. can be utilized from the crop during the period of darkness, a similar amount should be used during the longer hours of daylight, in which case the crop contents at dusk would represent slightly less than fifty per cent. of the total amount of seed collected during each feeding day.

It is considered that the time for seed intake to final excretion of waste would not exceed a 24-hour period with galahs.

Economic Considerations

With the large flocks of galahs throughout the pastoral areas of Australia, feeding almost entirely on seed of natural pasture species the loss of seed is of considerable importance. Although these plants seed prolifically, the quantity taken by birds must represent a significant percentage, and the loss would be greatly accentuated during poorer seasons when only limited quantities of grain were available. In drought periods when galahs are forced to search for every exposed seed, their influence is more apparent and the effect on subsequent pasture recovery following rains would be definitely retarded. A similar deleterious effect is most certainly created on deteriorated pasture land when the presence of seed supplies of the grass species is most essential for natural revegetation.

With agricultural projects now extending into the near western regions of Queensland it may be necessary in the near future to control the spread and unlimited breeding of these seed harvesting birds.

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INFILTRATION STUDIES ON A RED-BROWN EARTH IN THE RIVERINA

By A. L. TISDALL

Introduction

One of the problems associated with the establishment of irrigated pastures in the Riverina is the change in infiltration capacity which takes place in the early stages of growth.

The initial preparation of land for pasture that is to be flood irrigated involves grading operations as well as cultivation, and may constitute a fairly vigorous pulverisation. Parker and Jenny have shown[1] that cultivation under certain circumstances can decrease the infiltration rate in irrigated soils.

There is considerable evidence that the growth of pastures, particularly grasses, increases the aggregation of the soil[2,3], but the correlation between aggregation and infiltration is generally a matter of assumption. It has been shown[4] that under natural rainfall, infiltration is greater under pasture and lucerne than under maize cropping, but in this case both cultivation and plant growth may be contributing factors.

It was thought that the method of flood irrigation generally used in the Riverina district of New South Wales might be an important factor in influencing infiltration characteristics of a soil, in the initial years after it is cultivated and sown to pasture.

The experiment described here presents data which tend to confirm this assumption. The experiment was commenced in 1946, and data are presented for two years' studies.

Cobram loam, on which the experiment was conducted, belongs to the broad zonal group of red-brown earths described by Prescott.[5,6] In this case the soil was developed in a semi-arid climate. The soil type was first named and described by Butler *et al*[7], and with other similar types constitutes a large proportion of the lighter textured soils of the region.

The Experimental Area

A virgin area of some four acres was cultivated and prepared for border-check irrigation early in 1946, the bays being twenty-two feet wide and four chains long.

The pastures sown in April 1946, included *Lolium subulatum,* Vis., *Trifolium subterraneum,* L., and *Phalaris tuberosa,* L., *Trifolium subterraneum,* L. Control plots were also included; these were prepared similarly, but were not sown or irrigated and were kept free of weeds. There were three replicates of each treatment. The pasture plots were irrigated twice in each autumn and twice in each spring during the tests, and grazed as necessary.

Experimental Procedure

In January 1947, fifty-four six-hour tests were made on the established pasture plots, six being run on each replicate of each of the three treatments.

The tests were confined to a transverse strip across the bays, and fully randomised in time and position. The annual grass, *Lolium subulatum,* Vis., had made more vigorous growth than the perennial, *Phalaris tuberosa,* L.

The type of ring infiltration apparatus used was that developed by Pennefather,[8] shown in *Fig. 1.* The surface was not mulched before inserting the twelve-inch diameter ring, as it was considered that tests on the undisturbed surface would

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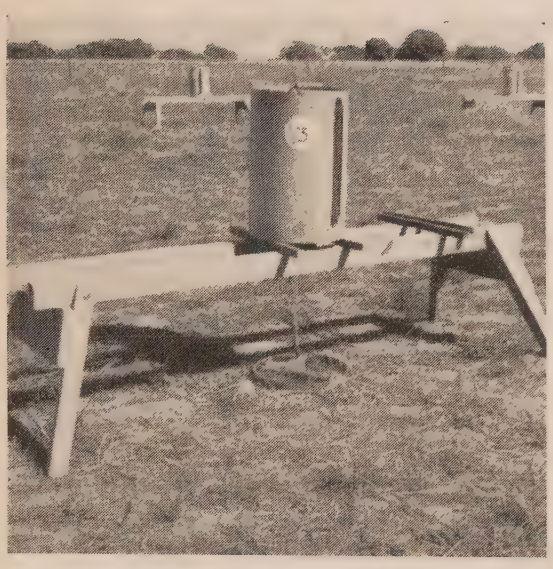

Fig. 1.
Infiltration Apparatus using a 12-inch Ring.

provide a better indication of the actual conditions in each treatment.

The above procedure was repeated in February 1948, following the growth of a good ground cover by both pastures, except that the tests were limited to two hours. The characteristics of the infiltration curve had been sufficiently established to allow extrapolation after that time. Soil moisture percentage was determined from samples taken in close proximity to the site of each test before wetting, and from within the ring site twenty-four hours after wetting. At the same time, measurements of apparent density were made on each treatment to a similar depth, using a sampling tube as described by Coile[9].

Expression of Results

It was found that the infiltration curves could be expressed reasonably accurately as $I = KT^{a}$ where

I = infiltration of water in inches.

T = time in hours.

and K and a are constants.

This expression is a modification of Kostiakov's equation[12], and was developed by Pennefather[8].

Results from the 1947 and 1948 tests were statistically analysed for the amount of infiltration, and also for the parameters K and a. In addition, the 1948 results were corrected for lateral penetration of water, and again subjected to statistical analysis. An estimate of the amount of water retained vertically below the ring was made from apparent density, and soil moisture before and after wetting, according to the method used by Marshall[10], which is similar to that mentioned by Israelsen[11]. Factors were obtained for each group of six simultaneous tests, the mean factor being 0.78. This implies that 78 per cent. of the absorbed water did not spread laterally.

Presentation of Data

The infiltration data are summarised in *Tables 1*, *2* and *3*.

The data summarised in the tables are shown in graphical form in *Fig. 2*, each curve being the mean of 18 tests.

The two seasons' results are presented separately. No quantitative comparison should be made between them, as they represent infiltration determinations under different soil moisture conditions.

Discussion of Results

The difference in infiltration between control and pastures in the 1947 tests is almost significant at the 5 per cent. level. Infiltration on the *Lolium subulatum/Trifolium subterraneum* pasture when taken alone is significantly less than the control. Although the difference between pastures and control is not quite significant at $P = .05$, the control shows a consistently higher infiltration when considering comparison between blocks. Further the control has a significantly higher K value than either treatment and a significantly higher a value than one of them. The joint effect is to make the infiltration on the control higher than either treatment. It seems that the application of irrigation water to cultivated land in the season following sowing, had a depressing effect on the absorption characteristics of the soil.

TABLE I

Mean Infiltration Values, and the Parameters K and α: January 1947

DETERMINATION	TREATMENT			SIGNIFICANT DIFFERENCE BETWEEN MEANS
	Lolium Pasture	Phalaris Pasture	Control	
Infiltration—Inches in 6 hrs. ..	2.94	3.89	6.71	3.54
Parameter K.	1.42	1.19	2.04	.60
Parameter α	.39	.62	.64	.24

TABLE II

Mean Infiltration Values, and the Parameters K and α: February 1948

DETERMINATION	TREATMENT			SIGNIFICANT DIFFERENCE BETWEEN MEANS
	Lolium Pasture	Phalaris Pasture	Control	
Infiltration—Inches in 2 hrs. ..	2.22	2.34	2.56	N.S.
Corrected Infiltration	1.71	1.70	1.95	N.S.
Parameter K	1.60	1.56	1.57	N.S.
Parameter α	0.47	0.58	0.69	N.S.

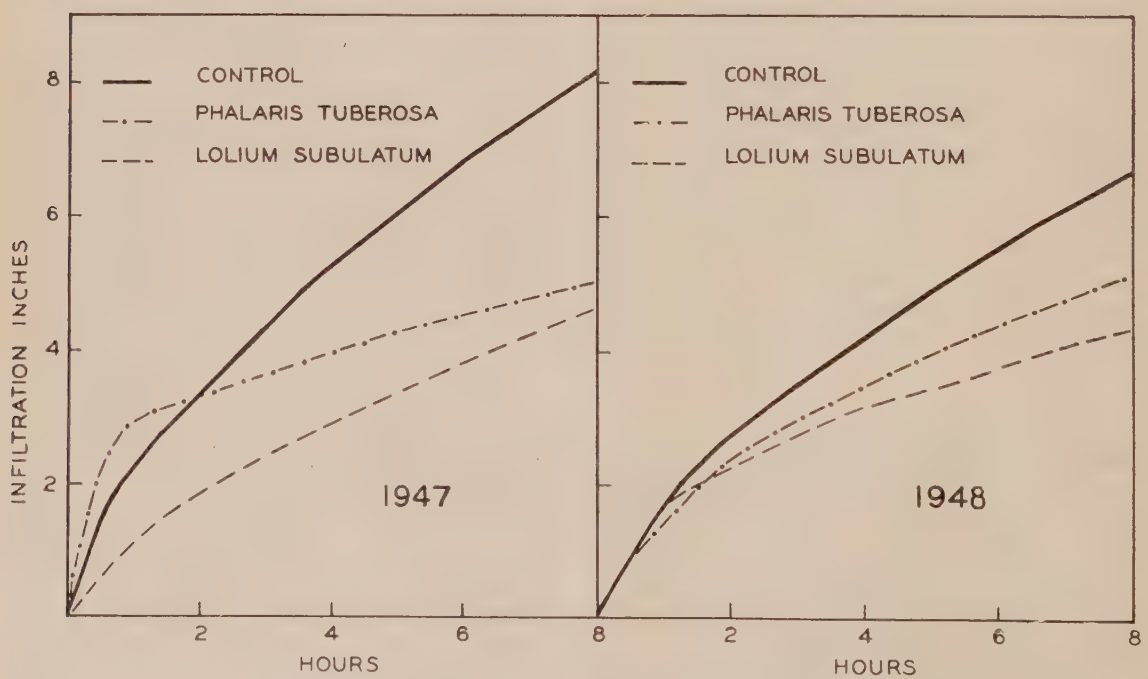

FIG. 2 MEAN INFILTRATION CURVES

TABLE III

Mean Infiltration — Inches in Six Hours — on Pastures and Weed-free Control: 1947 and 1948

Year	Irrigated Pasture Means of 36 Tests	Unirrigated Control Means of 18 Tests
January, 1947.	4.1	6.7
February, 1948.	4.0	5.4

In the 1948 tests the control again shows a higher infiltration than the treatments, but the differences are smaller and not significant. The use of the correction factor, as shown in *Table II*, did not alter this result. It is probable that the growth of pasture plants was beginning to counteract the initial depressing effect which the use of flood irrigation had on infiltration.

Conclusion

This experiment shows that the action of normal flood irrigation on a cultivated soil depressed its infiltration capacity.

Acknowledgments

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References

1. Parker, E. R., and Jenny, H., *Soil Sci.*, **60**: 5, 1945.
2. Martin, N. S., *East African Ag. Jour.*, April, 1944.
3. Russell, E. W., *Imp. Bur. Soil Sci. Tech. Comm.*, No. 37, 1938.
4. McHenry, J. R., and Fitts, J. W., Nebraska Ag. Expt. Sta., 59th An. Rep. (13), 1946.
5. Prescott, J. A., *Coun. Sci. Ind. Res. (Aust.) Bull.* No. 52.
6. Prescott, J. A., *Coun. Sci. Ind. Res. (Aust.) Bull.* No. 177.
7. Butler, B. E., *et al.*, *Coun Sci. Ind. Res. (Aust.) Bull.* No. 152.
8. Pennefather, R. R. Unpublished paper. Third International Congress on Agricultural Engineering, Rome, 1939.
9. Coil, T. S., *Soil Sci.*, 42: 139, 1936.
10. Marshall, T. J., Mimeographed Soils Divn. Report No. 15/44.
11. Israelsen, O. W. "Irrigation Principles and Practices," John Wiley and Sons, N.Y. (1946), p. 167.
12. Kostiakov, A. N., Trans 6th Commission, *Internat. Soc. Soil Sci.* (Russian), Part A: 15-21, 1932.

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TECHNICAL NOTES

THE OCCURRENCE OF SCORZONERA CALCITRAPIFOLIA VAHL. AT DENILIQUIN, NEW SOUTH WALES

Introduction

Scorzonera calcitrapifolia Vahl. a Mediterranean species, has been collected and identified at three scattered localities near Deniliquin; Conargo (1946), Deniliquin (1947) and Womboota (1949). This species has not, to our knowledge, been recorded before in Australia.

Description

S. calcitrapifolia is a glabrous perennial one foot in height with pinnatifid radical leaves and a thick fibrous rootstock. The specimens examined have from seven to ten flower heads on unbranched scapes, each head having 25 to 40 yellow ligulate florets. The achenes are greyish and striate with eight to ten ribs and a basal callus. The pappus consists of fine plumose bristles with long silky interwoven barbs. At both Conargo and Deniliquin flowering has been observed from July to September.

Distribution

According to Hegi[3], *Podospermum calcitrapifolium* DC. (=*Scorzonera calcitrapifolia* Vahl.) is "found as a ruderal on roadsides, borders, ditches, vineyards and waste ground. In central Europe it is only introduced and naturalised in the Rhineland near Rudesheim, and reported in Sauerland from Olk to Rahlingen near Trier, also in Alsace near Rosheim and Colmar. General distribution is south Europe from Portugal and Spain through south and south-east France, Italy (including Sardinia and Sicily) to Greece, Asia Minor, Caucasus, Persia, Baluchistan and North Africa.

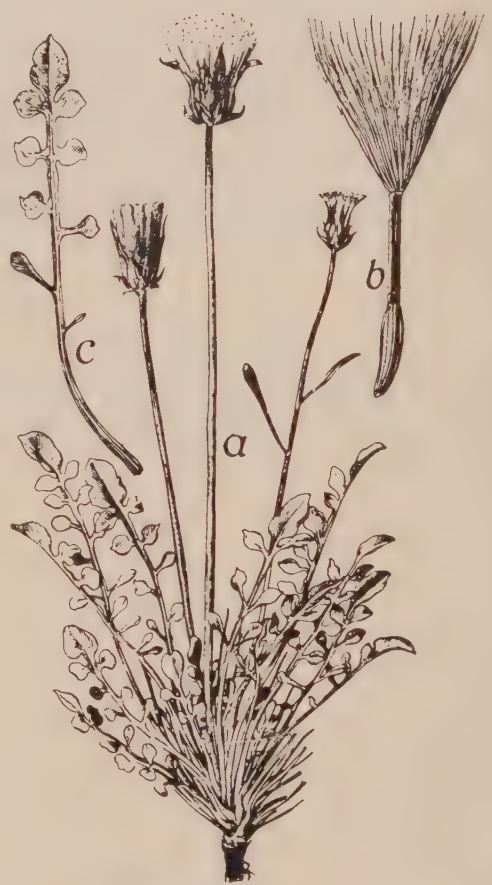

Fig. 1.
(a) Habit pappus.
(b) Fruit and pappus.
(c) Leaf.

"*P. calcitrapifolium* DC. (=*S. calcitrapifolia* Vahl.) is closely related to *P. laciniatum* (L.) DC. (=*S. laciniata* L.) but demands a more oceanic climate, and is included in the circum-Mediterranean-West Atlantic region. It is not indigenous

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COPPERS *Prepared Copper Fungicides, Copper Oxychloride*

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ALSO—Lead Arsenate, Wormkiller, Tartar Emetic, Hortomone, Shirlans, H.E.T.P., Agrals, etc.

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9 O'Connell Street, Sydney.

TABLE 1

Climatic and edaphic data relevant to areas where S. calcitrapifolia Vahl has been located.

RAINFALL 89 years' records		TEMPERATURE 41 years' records		SOIL	
Annual mean (inches)	15.5	Lowest monthly mean (July)	48.3	"Brown and Grey Soils of Heavy Texture" (Prescott, 1944)	
Percentage of annual rainfall in May-Oct.	57	Average monthly mean (May-Oct.)	53.4	Gilgai formation and "puff" section (Howard, 1939)	

Rainfall and temperature data from Commonwealth Meteorological records for Deniliquin.

in central Europe, but has perhaps been introduced into the Rhineland with the cultivation of vines." Black describes *S. laciniata* and gives its distribution as the "Southern districts of South Australia."

Habitat

Salient climatic and edaphic data related to the occurrence of *S. calcitrapifolia* Vahl. are summarized in *Table* 1.

Associated Vegetation

The associated plant community in each case is a *Chloris truncata-Danthonia semiannularis* Grassland[1] with the winter aspect of annual *Medicago* species and herbs, and the summer aspect of *Panicum* spp, *Sporobolus Caroli* Mez. and limited annual herbs. The main perennial species are *Danthonia semiannularis* R. Br., *Chloris truncata* R. Br. and *Stipa variabilis* Hughes.

No observations have been made on the reaction of *Scorzonera calcitrapifolia* to grazing.

Discussion

Scorzonera calcitrapifolia Vahl. has been observed near Deniliquin and its spread has not been rapid. This area is somewhat similar climatically to Southern Europe and slow spread as a weed of waste places and possibly on stock routes might be expected.

References

1. Beadle, N.C.W., "The Vegetation and Pastures of the Western Division of New South Wales with Special Reference to Soil Erosion," Government Printer, 1948.
2. Black J. M., "Flora of South Australia" 4; 658, Government Printer: Adelaide. 1929.
3. Hegi, P. J., "Illustrierte Flora von Mittel—Europa" J. F. Lehmanns: Munich. (1931).
4. Howard A., *Pedol.* 8; 14, 1939.
5. Prescott J. A., *Coun. Sci. Ind. Res. (Aust.) Bul.* No. 177, 1944.

O. B. WILLIAMS,

Regional Pastoral Laboratory,

C.S.I.R.O.,

Deniliquin, N.S.W.

(*Received for publication, 12th January* 1950).

THE SUSCEPTIBILITY OF PEAS TO FOUR DISEASES OCCURRING NATURALLY IN THE AUSTRALIAN CAPITAL TERRITORY

During the seasons 1946 to 1949 observations were made on four pea diseases which occur naturally at Canberra. These diseases are:—

Powdery Mildew (*Erysiphe polygoni* D.C.).
Ascochyta Blight (*Ascochyta pisi* Lib.).
Mycosphaerella Blight (*Mycosphaerella pinodes*. Berk. and Blox.).
Bacterial Blight (*Pseudomonas pisi* Sackett.).

The effect of each of these diseases has been observed on over three hundred varieties of *Pisum sativum* L. and on related species belonging to the genera *Pisum* and *Lathyrus*. The varieties of *P. sativum* included edible podded and field peas as well as garden peas and many were of Russian, Abyssinian, Balkan and Central Asian origin. The other species of the genus *Pisum* were *P. abyssinicum* A. Br., *P. elatius* M.B., *P. humile* Boisset and Noé, and *P. jomardi* Schrank. The species of *Lathyrus* included were *L. aphaca* L., *L. hirsutus* L., *L. ochrus* D.C., *L. pubescens* Porter and Coult, *L. sativus* L., and *L. tingitanus* L.

The main findings of the field observations and the results of artificial inoculations in the greenhouse are recorded below.

(a) Powdery Mildew

From observations of natural infection and from inoculation of leaflets floating on a 10 per cent. sucrose solution it was observed that young leaves of all the varieties and species of *Pisum* were resistant, but mature leaves were susceptible. There were slight differences between varieties in the amount of fungal growth and spore formation on leaves in the intermediate stage of growth. Six varieties that had been reported immune to powdery mildew[1] in Peru were as susceptible as the other varieties when grown at Canberra. These varieties are at present classified under the rather indefinite names of Peru 1, 2 and 3, Mildew Immune White (a), Mildew Immune White (b) and Mildew Immune Coloured. All of the species of *Lathyrus* tested were more susceptible than the garden pea, as dense fungal growth occurred on leaves of all ages.

(b) Ascochyta Blight

The varieties and allied species were tested for resistance to the leaf-spotting and stem-girdling phases of the disease, by spray inoculation under conditions of high humidity. Seedlings of any variety were more resistant than older plants of the same variety. If early, mid-season and late varieties were inoculated at the same time after planting, varieties of late maturity almost invariably appeared less susceptible than earlier varieties. The differences in susceptibility associated with differences in the stage of maturity were minimised by spraying all varieties at the time of appearance of the first flower. Austrian Winter, a variety of *P. sativum*, was highly resistant to stem girdling, less resistant to leaf spotting and susceptible to pod spotting. All the other varieties and species of *Pisum* were susceptible to all phases of the disease. Of the species of *Lathyrus* tested, *L. aphaca*, *L. hirsutus* and *L. pubescens* showed some field resistance. All the species were, however, susceptible to the disease when spray inoculated.

(c) Mycosphaerella Blight

Observations in the field, and greenhouse tests, showed all the varieties and species of *Pisum* to be susceptible, *Lathyrus hirsutus* was the only species of *Lathy-*

rus to remain free from symptoms in the field, but this species was readily infected by spray inoculation.

As with Powdery Mildew and Ascochyta Blight there is an increase in the susceptibility of peas to Mycosphaerella Blight as the plants approach maturity.

(d) **Bacterial Blight**

Not one of the varieties and species tested showed any appreciable resistance to the disease, although slight differences occurred between varieties in the number and size of the lesions. The varieties with the least extensive lesions belonged to the edible-podded group. This was noticed both under natural conditions and when the varieties were artificially inoculated by spraying, seed inoculation, or multiple needle inoculation.

D. C. WARK.
Division of Plant Industry,
C.S.I.R.O.,
Canberra, A.C.T.

Reference.

1. Harland, S.C., *Heredity*, 2: 263, 1948.

(*Received for publication, 18th January*, 1950).

SOME INSTANCES OF GREAT VARIABILITY IN INCIDENCE OF BROWN ROT OF STONE FRUITS IN CANBERRA IN 1949-50

Very marked differences in the incidence of brown rot of stone fruits were observed on trees in adjoining home orchards on any one of several days, each season from 1945 to 1949.[1] Weather conditions were uniform throughout the area on any of the days on which the observations were made. It was therefore deduced that the factor conditioning such extremes in disease incidence as were observed on any one day, could not have been prevailing weather conditions.

During the first week of December, 1949, while apricots were still green, the writer placed six test tubes containing sporulating cultures of *Sclerotinia fructigena* (Wint.) Rehm. on branches of a tree, in positions which were deemed favourable for distribution of conidia on to nearby fruit, including many at levels beneath the cultures. A few infected fruits were observed on the tree on the day this was done. Natural and artificial inocula were therefore available for three weeks before the first fruits ripened. But the loss due to brown rot was less than one per cent. of a crop of more than 2,000 fruit. If, as is generally accepted, inclement weather was the factor conditioning this disease, the very low incidence of brown rot in this tree might have been ascribed to the dry weather conditions prevailing during the period.

But in another tree, about 100 yards away, the loss by brown rot in a crop of approximately 250 was more than 66 per cent. If "building up" of inoculum were responsible in the present season for the high percentage loss on this latter tree, it were difficult to account for the failure to "build up" in the former tree to which inoculum was applied, except on the basis of differences in susceptibility, which did not appear to be inherent. To aid in "building up" inoculum in this tree, mummies were left for three seasons, not only on the ground, but on the twigs of this and adjoining trees of other species of *Prunus*. There seemed to be little, if any, relation between disease incidence and this provision for increasing inoculum.

There is also a mid-season peach in the home orchard in which stood the apricot tree just referred to as bearing more than 66 per cent. of rotted fruit. Two weeks after the apricots were ripe, brown rot was observed on some fruit on this tree, and within two weeks, all the crop, estimated at 450, was rotted. Fifteen yards to the east, in an adjoining property, there was another peach tree bearing about 200 fruit, all of which matured. Not one fruit was lost by brown rot. Thirty-five yards to the west of this tree, and therefore twenty yards to the west of the former tree, another in a neighbour's property was practically free from the disease, the loss being less than one per cent. The fruit on the three trees was at the same stage of maturity.

The performance of two Mayflower peach trees, one of which was from a bud from the other, might also be noted here. The older tree bore about 50 per cent. of brown rotted fruit out of a total of approximately 450, whereas only 10 per cent. of the crop on the other was affected. Two years previously, when the season was unusually wet, the corresponding losses were 100 per cent. and 7 per cent.

Brown Rot was more destructive to nectarines this season in Canberra than to any other host. Few trees in the older suburbs bore crops which were not entirely destroyed by it. There were but two small areas in one of the newer suburbs in which nectarine trees bore a high percentage of disease-free fruit. In one of the areas, four trees within fifty yards of each other, bore crops with less than 10 per cent. loss. On a neighbour's tree which was about ten yards from one of these trees, the loss exceeded 95 per cent.

The results of these and previous observations suggest that the main factor conditioning brown rot on the trees under observation cannot be the prevailing weather, and that the incidence of disease does not appear to be related to attempts to "build up" inoculum. Susceptibility to brown rot in peach trees from the same stock does not appear to be inherent, but induced by conditions peculiar to the immediate environment of the tree.

Reference

1. H. R. Angell.—"Observations on brown rot of stone fruits in four Canberra suburbs." *J. Aust. Inst. Agr. Sci.* 15: 159, 1949.

H. R. ANGELL.

Division of Plant Industry,
C.S.I.R.O.,
Canberra, A.C.T.

(*Received for publication 17th March*, 1950.)

ANNUAL REPORT OF COUNCIL

Report of Council Presented to the Fourteenth General Meeting held at C.S.I.R.O., Canberra, on the 21st March, 1950.

Ladies and Gentlemen:

Your Council has pleasure in presenting its Report for the year ending 31st December, 1949, which is the fifteenth year of Institute activity.

Transfer of office from New South Wales to the Australian Capital Territory Branch was effected at the 13th General Meeting on January 10-11, 1949, and the Office Bearers for the remainder of the year were as follows:—

President: Professor J. R. A. McMillan.
Hon. Gen. Treasurer: Mr. W. Ives.
Hon. Gen. Secretary: Mr. G. A. McIntyre

Delegates:

Branch.	Principal Delegate.	Proxy.
Q'ld.	Mr. C. Winders	Mr. C. S. Greenham.
N.S.W.	Mr. E. J. Breakwell	Mr. C. M. Donald.
A.C.T.	Dr. T. H. Harrison	—
Vic.	Dr. H. C. Forster	Mr. P. A. Reid.
Tas.	Mr. W. F. Walker	Dr. W. V. Ludbrook.
S.A.	Mr. R. I. Herriot	Mr. C. H. Williams.
W.A.	Mr. A. S. Wild	Mr. F. O. Grogan.

Thirteenth General Meeting.—The Thirteenth General Meeting was held at Hobart on January 10-11, 1949, for the transaction of formal business of the Institute, the consideration of constitutional amendments and discussion on selected topics of current interest. *Mr. A. R. Brimblecombe,* on behalf of *Mr. A. F. Bell,* delivered the Presidential Address entitled "Twenty Years of Disease Control." The second award of the Australian Medal of Agricultural Science was made to *Professor W. L. Waterhouse,* for his outstanding work on cereal genetics and breeding.

Interchange of Personnel.—A letter of protest against restrictions on interchange of personnel was forwarded by the Joint Standing Committee of Professional Scientific Bodies to the Prime Minister and State Premiers. Their replies were collated and circularized to the associated institutions. It is evident that restrictive practices are still operative, and Council has drafted a further letter of protest for consideration by the Joint Committee.

A Memorandum advocating the general interchangeability of superannuation rights prepared by the previous Council and ratified at the 13th General Meeting has also been forwarded to the Joint Standing Committee.

Salaries and Status.—Acting on a resolution of the 13th General Meeting Council recommended to Branches the collation of data on the relative status of the professions in the State Public Services, examination of the possibility of altering the present system of tribunals and the greater use of Institute publicity. Specific action taken has been the preparation of a report on the Commonwealth Public Service. A salary status survey of members in conjunction with the Melbourne University Appointments Board is under consideration, and Victorian Branch members were responsible for a special newspaper supplement on the contribution of Agricultural Science to Victorian Agriculture.

Rural Extension Services.—Your Council pressed for the visit of a U.S. Extension Officer under the auspices of F.A.O.

and the Agricultural Council, but the proposal was not acceptable to this latter body as in the opinion of Ministers it is preferable to send Australian Officers overseas. The possibility of an independent assessment of the effectiveness of extension services through a field survey by University research students was pursued with the Commonwealth Office of Education. A recommendation of this body that the project be considered by the University Councils has gone forward.

A factual survey of the present position of extension services in each State has been made by the Branches, and their reports are in process of collation.

Agricultural Engineering.—Statements have been provided on the present facilities for training in Agricultural engineering in each State, and Branch views on future extension of these facilities. These statements have been collated, and the report is under review by Branches before forwarding to University and State authorities.

Scholarships and Studentships. — The revised report on facilities existing in the Commonwealth for Agricultural workers to proceed overseas has been completed and presented for publication.

It was decided by Branches that they should retain the initiative in taking action through Council seeking travelling concessions and subsistence for Agricultural Scientists in State Services to visit approved institutions in other States during leave periods.

Two Branches have taken such action, one securing the concession sought.

Review of Memorandum and Articles of Association.—A number of Amendments to Articles of Association principally alterations consequential on amendments accepted at the 13th General Meeting have been examined during the year, and will be considered for adoption at this meeting.

Australian Journal of Agricultural Research. — The Commonwealth Scientific and Industrial Research Organization has undertaken the publication of a new journal on Agricultural Research open to its officers and outside contributors. The Institute and the Australian Veterinary Association have been invited to co-operate in its production, and Council has signified its willingness to participate. A Committee has been formed to tender advice to C.S.I.R.O. on articles submitted and on matters of a policy nature. It has been agreed that the Institute should have representation on this Committee, and Professor G. W. Leeper consented to act as liaison officer.

An arrangement has been made with C.S.I.R.O. whereby members of the Institute can secure copies of the A.J.A.R. at substantially reduced rates.

The machinery for ordering and distribution has been established with *Mr. W. Ives* as Distribution Manager.

Association of the Institute with A.N.Z.A.A.S. (Section K).—Consideration was given by the Committee of Section K to the proposal by the Institute to separate Agriculture and Forestry. The creation of a new section for Forestry was not acceptable to Council of A.N.Z.A.A.S., and, as Forestry preferred to be associated with Agriculture rather than with Botany, it was decided to continue the existing arrangement particularly as it is always possible to arrange sub-sections at meetings, without the necessity for a clear separation.

A.I.A.S. Journal.—The personnel of the Publications Committee during 1949 were:—

Hon. Editor: Mr. A. Shavitsky.

Hon. Business Manager: Mr. P. A. M. Bell.

Hon. Assistant Business Manager: Mr. J. Orr.

Committee Members: Mr. P. T. Mitchell, Mr. J. A. Baker, Mr. R. D. Croll, Dr. H. C. Forster and Dr. N. S. Noble.

The third issue of Vol. 15 was very seriously delayed, and the Publications Committee decided to combine it with the December number. It is hoped that the lag in publication will be eliminated by the first issue of Vol. 16.

McCleery and *Professor J. R. A. McMillan.*

Finance.—Income for the year fell from £754 to £496 due to a very substantial increase of arrears in subscriptions. Expenditure decreased from £459 to £409

Membership.

Corporate Membership:

Branch.	Total	N.S.W.	Vic.	S.A.	W.A.	Q'ld	A.C.T.	Tas.
Membership as at 31/12/48	675	190	180	88	70	66	54	27
Admissions in 1949	48	12	18	9	—	7	—	2
Gains by transfer	—	6	—	1	1	—	3	2
Losses by transfer	—	1	4	8	—	—	1	1
Resignations	7	4	1	—	—	2	—	—
Cancellations	2	—	1	—	—	—	1	—
Deaths	—	—	—	—	—	—	—	—
Membership as at 31/12/49	714	203	192	92	71	71	55	30

Student Membership:

Membership as at 31/12/48	154	110	7	22	12	3	—	—
Admissions in 1949	40	4	11	17	—	8	—	—
Gains by transfer	—	—	—	—	—	—	—	—
Losses by transfer	—	—	—	—	—	—	—	—
Resignations	7	4	1	—	—	2	—	—
Cancellations	11	1	7	1	1	1	—	—
Deaths	—	—	—	—	—	—	—	—
Membership as at 31/12/49	176	109	10	38	11	8	—	—

Qualifications Committee.—During 1949 the Qualifications Committee consisting of *Messrs. A. J. Vasey* (Convener), *J. A. Aird* and *G. H. Vasey* has rendered a much appreciated service to Council by its investigation of all applications for corporate membership. Arrangements have been made for transfer of the office in 1950 to a N.S.W. Branch Committee consisting of *Dr. E. T. Edwards, Mr. F. C.*

due to reduced Council costs and Journal costs. The excess of income over expenditure was £87 in 1949 as compared with £296 in 1948. At the end of the year the accumulated fund of the Institute amounted to £1,150.

On behalf of the Council,

J. R. A. McMILLAN,

President.

Journal of the Australian Institute of Agricultural Science Account

ANALYSIS OF CASH RECEIPTS AND PAYMENTS FROM APRIL 20, 1948, TO FEBRUARY 21, 1949.

RECEIPTS.			EXPENDITURE.	
Brought Forward—			Printing and Publishing—	
Cash at Bank	£32 11 4		Vol. 14 No. 1	£83 6 11
Petty Cash	15 7		Vol. 14 No. 2	169 7 5
	£33 6 11		Vol. 14 No. 3	142 18 11
A.I.A.S. Subsidy	300 3 9		Vol. 14 No. 4	126 2 9
Advertising—			Reprints	47 12 5
Vol. 14 No. 2	121 4 0		Exchange	1 2 3
Vol. 14 No. 3	93 9 8		Petty Cash and Sundries	11 2 2
Vol. 14 No. 4	26 9 2		Stationery	13 14 5
Reprints	42 17 5		Typing	3 1 6
Back Volumes and Nos.	24 9 8		Advertising Representatives' Commission	86 5 5
Subscriptions, Vol. 14	68 0 1		Artists' Charges	18 5 9
Subscriptions in Advance	4 17 7		Balance in Commonwealth Savings Bank	11 18 4
	£714 18 3			£714 18 3

Audited and found correct.
CLEVELAND, SON AND HISLOP.
Chartered Accountants (Aust.).

The Australian Institute of Agricultural Science

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st DECEMBER, 1949.

EXPENDITURE.			INCOME.		
Audit Fees		£10 10 0	**Subscriptions Received—**		
Council Expenses		4 6 6	New South Wales Branch	£95 11 0	
General Meetings		77 12 2	Victorian Branch	152 9 0	
Cost of Journal		219 5 11	South Australian Branch	59 14 0	
Petty Cash and Incidentals		81 8 7	Queensland Branch	38 11 0	
Honoraria—			Australian Capital Territory Branch	51 9 0	
Mr. McCleery	£10 10 0		West Australian Branch	69 0 0	
Mr. Mandelson	5 5 0		Tasmanian Branch	7 7 0	
	15 15 0			£474 1 0	
Excess of Income over Expenditure		86 19 5	**Less** Subscriptions in Advance, 31st December, 1949	4 4 0	
				£469 17 0	
			Add Subscriptions in Advance, 1st December, 1949	9 8 0	
					£479 5 0
			Sundry Receipts		7 0
			Bank Interest		16 5 7
		£495 17 7			£495 17 7

The Australian Institute of Agricultural Science

BALANCE SHEET AT 31st DECEMBER, 1949.

LIABILITIES.			ASSETS.		
Sundry Creditors	£129 4 8		**Cash at Bank—**		
Subscriptions Paid in Advance	4 4 0		Australian Capital Territory	£265 13 0	
Accumulated Funds—			Melbourne	92 11 0	
Balance, 31st December, 1948 £1,062 18 2					£358 4 0
Add Excess of Income over Expenditure for the year ended 31st December, 1949 86 19 5			**Petty Cash**		13 14 9
	1,149 17 7		**Commonwealth Govt. Bonds—**		
			3¼% — 15th August, 1956	£100 0 0	
			3½%—15th November, 1958	100 0 0	
			3¼% — 15th September, 1959	200 0 0	
			3½%—15th October, 1963	200 0 0	
			3⅝%—15th October, 1963	300 0 0	
					900 0 0
			Office Furniture		11 7 6
	£1,283 6 3				£1,283 6 3

REPORT OF THE AUDITORS.

We have examined the above Balance Sheet. Figures relating to the cost of the "Journal of Agricultural Science" for the period from 1st March, 1949, to 31st December, 1949, have been incorporated from statements which have not been audited. Subject to this remark, we have obtained all the information and explanations we have required, and in our opinion, such Balance Sheet is properly drawn up so as to exhibit a true and correct view of the state of the affairs of the Institute according to the best of our information and the explanations given to us and as shown by the books of the Institute.

COOPER BROTHERS, WAY & HARDIE,
Chartered Accountants (Australia).

27th February, 1950.

AUSTRALIAN JOURNAL OF AGRICULTURAL RESEARCH

The first number of the new periodical the Australian Journal of Agricultural Research has now been published. This Journal which will be published quarterly is available to members of the Institute at the concession rate of 12/6 per annum. (Ordinary subscription is 30/- per annum.)

Institute members wanting to receive this Journal should forward a cheque for 12/6d to the Distribution Manager:—

Mr. W. Ives,
C.S.I.R.O.,
314 Albert Street,
East Melbourne, C.2.
Victoria.

In the case of those members who have already subscribed seven shillings for the two issues which were to have been published in 1949, a balance of 5/6 will secure all the four issues to be published in 1950. Such members may forward a cheque for 18/- which will cover all issues to be published in 1950 and 1951.

For those members who only wish to receive copies as from the next (second) issue, a cheque for 9/6 should be forwarded.

GENERAL

TRAVEL LEAVE FOR AGRICULTURAL SCIENTISTS

Acting upon a suggestion submitted by the Publications Committee Council, at its October meeting last year decided that copies of the June issue of Vol. 15 of the Institute Journal should be forwarded to the Ministers of Agriculture, drawing their attention specifically to the proposal of Professor Currie that the Department should consider a policy of granting travel leave to its promising officers, analogous to sabbatical leave in the Universities.

Excluding acknowledgments, the following replies have been received from the Ministers of Agriculture:

New South Wales

"As far as my department is concerned, it is agreed in principle that it is most desirable that these officers should be granted leave under suitable conditions, so that they may obtain experience overseas. You will realise, however, that it is a very difficult matter indeed to arrange that funds should be provided for this purpose more or less as a routine procedure.

"On the other hand, special facilities have, in fact, been made available for officers in this Department to travel overseas and obtain information which it is thought has been and will be of great value to the Department, and also to enable the officers themselves to comply with the conditions of post-graduate scholarship awards, which they have obtained in some cases. Since the end of the war, 22 officers of my Department have been given such facilities, and of these, 8 are still abroad in the United Kingdom or the United States."

Victoria

"I have perused the article to which you have drawn my attention, and while the course advocated by Professor Currie has much to commend it, I am afraid that so few graduates of 6 or 7 years' standing would be able to avail themselves of the opportunity to travel on the basis proposed, that such a policy would result in officers being selected by reason of their private means, rather than on their capacity and the needs of the Department.

"The present policy which is being followed by my Government in respect of scientific officers in the Department of Agriculture is that each year, an officer is chosen for the purpose of making investigations abroad, and the whole of the costs involved are borne by the Government. This enables an officer of the requisite qualifications to be chosen regardless of his financial position, and for him to undertake an investigation abroad which the Department specifically requires."

Queensland

"I am quite in accord with this as a principle, although not quite subscribing to the frequency and generality advocated by Professor Currie. However, as earnest as is my sympathy with his views, I may state that there are in this Department, some 20 officers who have had overseas experience during their period of Department association, while some dozens have spent varying periods at Institutions outside Queensland."

Tasmania

"I am in accord with the general views expressed by Professor Currie on this matter, and as opportunity offers, professional officers with the Department of Agriculture in Tasmania will be granted facilities for this purpose."

COMMONWEALTH AGRICULTURAL BUREAUX

NEWS NOTES

Review Conference, 1950

All countries of the British Commonwealth have agreed to send delegations to the C.A.B. Review Conference in London in June and July next. It is probable that the Australian delegation will be led by Dr. I. Clunies Ross, Chairman of C.S.I.R.O.

The Review Conference is charged with reviewing all the activities under the control of the C.A.B. Executive Council and with consideration of proposals for new activities. Among new and expanded activities proposed are: extensions to the Commonwealth Mycological Institute; the appointment of a Plant Expeditions Committee with a salaried secretary; and the establishment of new bureaux to deal with Agricultural Economics and Wild Life Management.

Changes of Official Correspondents

During 1949 the following appointments have been made:—

1. Professor J. A. Prescott, C.B.E., has resigned as Official Correspondent for the Bureau of Soil Science after 20 years' service, and Associate Professor G. W. Leeper, of the School of Agriculture, Univerity of Melbourne, has been appointed to succeed him.
2. Mr. A. T. Pugsley, of the Waite Agricultural Research Institute, has replaced Professor H. C. Trumble as Official Correspondent for the Bureau of Plant Breeding and Genetics.
3. Mr. I. F. B. Common, of the C.S.I.R.O. Division of Entomology, Canberra, has succeeded Mr. J. H. Smith as Official Correspondent for the Commonwealth Institute of Entomology.

New Publications

New publications of interest are:—

"Pregnancy Diagnosis Tests: A Review" (1948) 18/9

"The Spectrographic Analysis of Soils, Plants and Related Materials" (1948) 15/8

"The Practice of Soil Conservation in the British Colonial Empire" (1948) 12/6

"Proceedings of the First Commonwealth Conference on Tropical and Sub-Tropical Soils, 1948" (1949) 31/3

"Technique of Breeding for Drought Resistance in Crops" (1948) 3/2

"The Grasslands of Latin America" (1948) ..... 25 –

"Seed Production of European Vegetables in the Tropics" (1948) 2/6

"Growth Substances and Their Practical Importance in Horticulture" (1948) 15/8

These and all earlier C.A.B. technical communications may be obtained through the C.A.B. Liaison Officer, at 314 Albert Street, East Melbourne, C.2.

INDEXES FOR VOLUMES 14 AND 15.

Readers are advised that the indexes for Volumes 14 and 15 will be published with the next (June) issue of this Journal.

DIGESTS

PROCEEDINGS OF THE FIRST COMMONWEALTH CONFERENCE ON TROPICAL AND SUB-TROPICAL SOILS

(Commonwealth Bureau of Soil Science Technical Communication No. 46, 1949, pp. 235. Obtainable from technical book shops or from the C.A.B. Liaison Officer, 314 Albert Street, East Melbourne, C.2. Price 31/3).

The papers given at this conference, together with the discussions in a shortened form, occupy 235 pages. They consist of four sections: (1) Descriptions of predominant soils of the tropics and sub-tropics; (2) Classification; (3) Fertility Problems; (4) Soil erosion and miscellaneous problems. While the conference was organized by the Commonwealth Bureau, contributions were also invited from Belgian, Dutch and French colonies, and from the United States of America. Tropical Australia is dealt with in a paper by C. G. Stephens.

The volume is especially valuable because so little descriptive work on tropical soils has been collected in book form before. The descriptive section provides an opportunity for comparing Australian soils with their relatives in Africa. The section on classification also has useful material in spite of the confused state of the subject. The shrewdest explanation of this confusion comes from G. W. Robinson (p. 132), to the effect that soil classification is a philosophical problem, and that pedologists have unconsiously followed Plato in accepting the existence of "ideal" soil groups, of which all observed examples are but particular manifestations. A great deal of thought is still needed to make a good classification, but this conference is bound to lead to fresh efforts.

The highly leached soils of hot and wet climates have their own problems of fertility, some of which are mentioned in the third section. Three of the most valuable contributions in the last two sections of the book are (1) The Design of Rotation Experiments, by F. Yates; (2) The Soil Requirements of the Banana, by J. Baeyens, dealing mainly with the Belgian Congo; and (3) The Cereal-fallow rotation in Cyprus, by P. A. Loizides. This last paper belongs to temperate rather than tropical agriculture, and puts forward surprising evidence of the accumulation of total nitrogen in soils during a fallow period.

G. W. LEEPER.

THE PRACTICE OF SOIL CONSERVATION IN THE BRITISH COLONIAL EMPIRE

By SIR HAROLD A. TEMPANY

(Commonwealth Bureau of Soil Science Technical Communication No. 45, 1949, pp. 106. Obtainable from technical book shops or from the C.A.B. Liaison Officer, 314 Albert Street, East Melbourne, C.2. Price 12/6.)

This Technical Communication is the first detailed account to be published of the progress of soil conservation and erosion control in the British Colonies as a whole. The author has had wide experience of soil-conservation problems both as Agricultural Adviser to the Colonial Office and previously as administrator and Director of Agriculture in different colonies. In the preparation of the Technical Communication he has been in direct communication with the Directors of Agriculture in the territories concerned and has thus been able to include much up-to-date material from unpublished records and from published sources not easily accessible to the reading public.

As Sir Harold Tempany remarks, there is "growing realization that conservation measures should not be regarded as separate ends in themselves, but must be integrated into systems of husbandry capable of maintaining and enhancing soil fertility." To a great extent the future of many of the colonies depends on how successfully they solve the problems of soil erosion. The colonies have naturally not progressed so far in this direction as more advanced countries such as the United States and some of the Dominions, yet their progress towards conservation agriculture has often been remarkable, especially considering that several of the measures described have had to be specially devised for tropical or local conditions.

The Technical Communication is profusely illustrated with diagrams and photographs.

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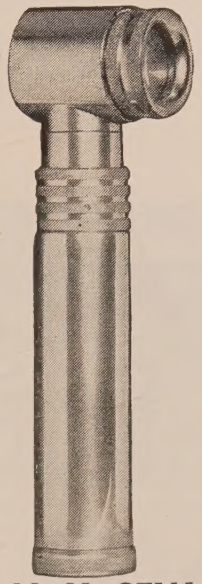

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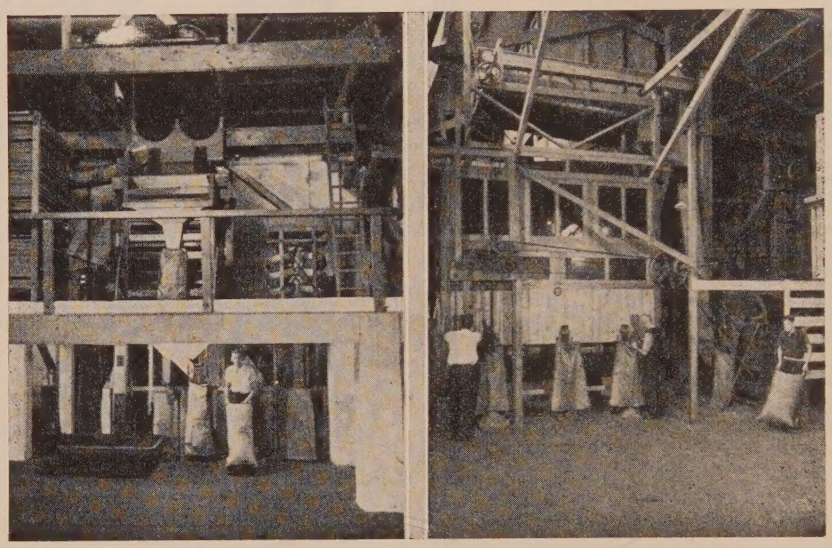

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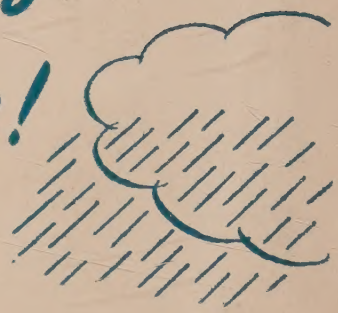

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